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The Hudson River Bridge at Waterford, New York.

By H. N. PECK.*

On July 10, 1909, fire destroyed the noted Burr bridge across the Hudson at Waterford, N. Y., between that village and Upper Troy, doubtless the oldest and at the same time one of the longest wooden bridges in this country. It was a four-span structure of total length about 750 ft., built in the years 1803-1804.

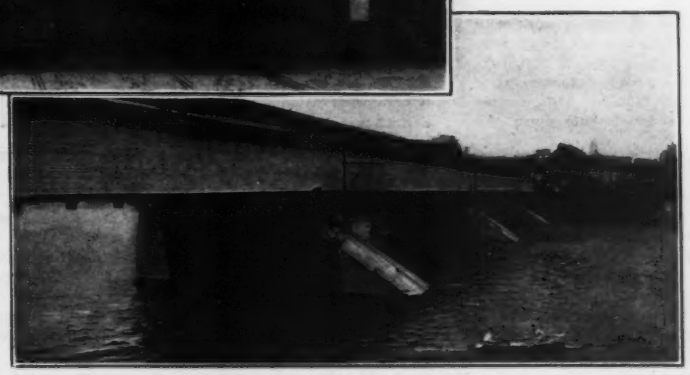
At the time of its destruction it was in excellent condition, showed no evidence of decay, and carried a heavy suburban traffic, including the 25-ton interurban trolley cars, of the Hudson Valley Railway Co.

The three lines of Burr trusses, providing two roadways of about 10 ft. clear width each, were built of hewn white and red pine timber cut from the adjoining country, and held by hand-forged bolts and nuts with white oak pins and wedges. Except for some reinforcement of the curved arch members about nine years ago, and some additional floorbeams added, the structure was as originally built 105 years ago. One arch member contained a red pine timber 14 by 15 ins. by 65 ft. long. Tightly enclosed in pine sheathing and a shingled roof, the bridge was so dry that its destruction by fire took less than thirty minutes.

It is, perhaps, interesting to note that the opening of the old bridge on December 11, 1804, was celebrated by a public holiday on both sides of the river. The crossing of the official party at noon, "under the discharge of seventeen cannon," included the governor of the State of New York, the Secretary of State, and the State Comptroller, with officials of the two villages, who then participated in a public banquet at the expense of the stockholders of the company.

After the fire the bridge was rebuilt, a steel truss superstructure being placed on the old piers. The new bridge consists of four steel pin-connected Pratt truss spans designed for a reinforced-concrete floor and wood-block pavement. A roadway 22 ft. 5 ins. wide, two tracks for trolley cars; two 6-ft. sidewalks are supported by cantilevers outside of the trusses. The grade is level on the two river spans, but raised about 3 ft. above the old elevation to provide the necessary clearance above the new Barge Canal; this required a uniform grade in each shore span of 2.32%.

The new bridge is supported upon the old piers and abutments, which were but little damaged. They were of rubble masonry laid in natural cement mortar. Removing this masonry for an average depth of 4 ft., below the old bridge seats disclosed the interior of piers to be in excellent condition. Few if any stones below this depth could be loosened with a pick and shovel; the mortar was remarkably sound, considering its age and service, and but little repointing was necessary upon the faces.



FIGS. 1 AND 2. TWO VIEWS OF THE OLD BURR-TRUSS BRIDGE ACROSS THE HUDSON RIVER AT WATERFORD, N. Y.
(Built 1804. Destroyed by fire 1909.)

For distributing the greater weight of the new structure upon this old masonry, all piers and abutments were capped with a concrete slab 4 ft. thick. The concrete was made quite rich, 1:2:4, and the slab was thoroughly reinforced with steel rods in the top and bottom flanges. The concrete was deposited on the piers by a derrick scow on which a mixing plant was installed, materials being delivered to it from canalboats.

The ice-breakers of the old piers were removed for a depth of 2 ft., and the surface layer was replaced with one-man stone laid as tight as possible and filled with Portland cement grout. Oak timbers bolted into this work provided spiking pieces for 2-in. yellow pine planking which covered the whole.

The falsework bents for the steelwork were framed on shore. They were erected by a specially designed falsework traveler. The river bottom is ledge rock about 12 ft. below water level, and no particular difficulty was experienced in setting the bents. The falsework for two spans was erected complete from the Waterford end and re-erected for the other spans as soon as the steel was connected.

The steel arriving at the bridge site was readily handled, sorted and stored at the Waterford end of the bridge by two stiff-leg derricks. These were operated by a Lidgerwood hoisting engine, which later served for erection of the first two spans, and also furnished steam for the air-compressor outfit for riveting the entire structure. A second engine set up on the center pier served for erecting the last two spans.

Material was delivered to the traveler from storage on push cars running on temporary track laid on the falsework. The specially designed three-bent erection traveler, which covered two whole panels of the bridge, did excellent work in the steel erection, and no difficulty was experienced. With the exception of the roadway stringers and sidewalk brackets, span No. 2 was erected complete and swung clear in just six days, and the entire structure in about 35 working days.

Owing to the lateness of the season in which the structure was ready for concreting, it was decided to lay a temporary yellow pine floor, which also enabled the bridge to be opened for traffic earlier. It was opened on Dec. 18, 1909. Final painting was also left for warmer weather, the structure having been given two coats of Dixon's graphite paint, applied to all steelwork below the floor.

The trusses are designed to carry a live-load of two 50-ton trolley cars on either or both tracks and a uniform live-load of 300 lbs. per lin. ft. on either or both sidewalks. The design of steelwork in the floor system is noteworthy as a substantial saving of metal is effected. Heavy long-

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itudinal girders placed near the trusses support transverse floorbeams, providing short panel lengths for roadway stringers. This is the same system as was used by the designers for the new Municipal Bridge over the Mississippi River at St. Louis. Greater economy is obtained in this construction than in the conventional method of transverse floorbeams at the panel points only, supporting heavy longitudinal stringers.

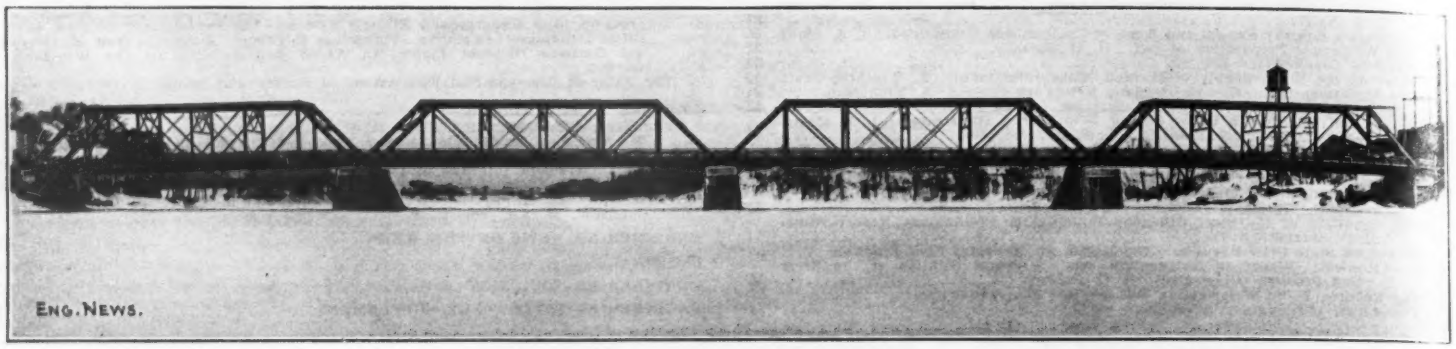


FIG. 3. NEW WATERFORD BRIDGE.

(Built 1909. The original rubble piers were used, a 4-ft. reinforced-concrete slab being substituted for the top of the old masonry.)

Messrs. Boller & Hodge, New York, were the designing and consulting engineers. The writer represented them on construction as resident engineer. The steelwork was fabricated and erected by the Phoenix Bridge Co., Phoenixville, Pa. The structure is owned by the Union Bridge Co., of Waterford, N. Y., Mr. Thos. A. Knickerbacker, President.

Industrial Lighting with Incandescent Lamps.*

By J. D. HOIT, P. F. BAUDER and H. S. HALL.†

By experience and observation the manufacturer, whether as a central station customer or as the owner of an isolated plant, has learned what an important part light plays in the satisfactory and efficient operation of his plant. To-day we find him not only constructing expensive buildings designed to utilize as much daylight as possible, but also improving his artificial lighting system. Average daylight has been found adequate to meet nearly any operating condition irrespective of the type or location of the machinery employed. This has in part been due to the fact that daylight is highly diffused. In those mills which operate the entire 24 hours, as much, or even more, attention should be paid to the location of artificial units as is given to the position that an operator takes with reference to the daylight received from windows or skylights. Unless it is necessary, he should never face directly an unshaded window.

In many instances a workman is obliged to work with the aid of what little light sifts in through dingy windows or what is received from an 8 or 16 c.-p. bare carbon lamp, the manufacturer considering reflectors as a luxury in which he should not indulge. This causes excessive eye and nerve fatigue which cuts down the productive ability of the employee.

In old installations it was customary to allow the carbon lamps installed to remain in service without attention until they were either broken or burned out. Results obtained on twelve lamps in an automobile machine shop, showed that practically all of them were extremely inefficient and below nominal candle-power. In one instance a 16 c.-p. lamp was delivering only 4.7 c.-p., which meant an efficiency of 9.32 watts per candle. It was shown in tests that the percentage of light cost, where lamps were moved about by the workmen, varies from 6 to 50%. This, in itself, should justify placing the lamps out of the employee's reach.

Where poor light exists, both the quality and quantity of products suffer, due to the workman being unable to see his work clearly. Insufficient light not only causes a feeling of depression, but also paves the way for costly mistakes. Many accidents which occur may be attributed as the direct result of poor illumination.

For comparison and simplicity the systems employed in providing satisfactory artificial illumination are divided into three general classes: (1) general illumination; (2) specific illumination; (3) composite illumination.

The first division applies to all methods and systems used where a more or less even intensity of light is desired over the entire floor area, where the work need not be especially accurate or where it is performed mechanically. For this class of lighting, high candle-power incandescent lamps should be used.

Specific illumination deals with individual lighting or where a higher degree of illumination is required at the working point than would be economical over the entire floor area. Specific illumination is provided by installing lower candle-power units closer to the various machines.

Composite lighting embodies both the general and specific, for example, over erecting floors or the alteration room of a department store.

In the above classification, each system has a different use and usually requires special care in its selection.

Fig. 4. Erection of Last Span of Waterford Bridge.
(The timber traveler running on the top of the false-work handled the entire erection.)

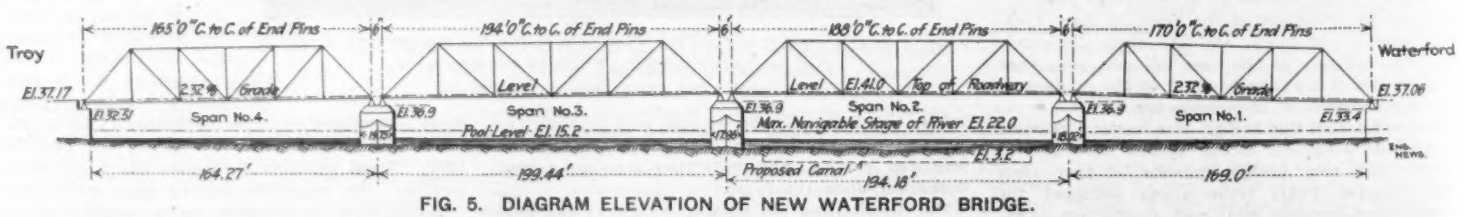


FIG. 5. DIAGRAM ELEVATION OF NEW WATERFORD BRIDGE.

Failing to appreciate the result desired or applying the wrong system often involves considerable unncessary expense to the manufacturer and dissatisfaction on the part of employee.

In metal-working shops of large area the lighting of the various machines was generally inadequate because high candle-power units were used, spaced too far apart, due to their excessive installation cost. Where close work is being done, the necessity of a specific lighting system is generally apparent, especially where a general system alone would, on account of the numerous shadows, etc., tend to produce cross shadows on the work. We do not understand that the authors recommend, in cases where "specific" lighting is used, that the rest of the shop should be so dark that workmen must stumble against from machine to machine. Too great contrast between an intense illumination of the work and the body of the shop is apt to cause excessive eye fatigue.—Ed.]

In the textile industry, several operations, such as cleaning and dyeing, must be applied to the raw products before they are sent to the finishing mill. In all of these operations a general type of artificial illumination is required. Not only must sufficient light be obtained, but its color value, which is of prime importance in the dyeing and inspection of the raw products, must be correct. This is accomplished to good advantage by high candle-power tungsten filament incandescent lamps. In thread mills the operator is compelled to watch each individual thread to see that it does not break and also to remove rough spots. The operators are greatly hampered in this work by having the light shining into their eyes when artificial light is necessary.

The lighting system which has been generally prevalent in cloth weaving mills, using bare carbon lamps of doubtful candle-power, has, in many instances, been displaced either by single 40 or 60-watt tungsten filament lamps equipped with suitable reflectors, or, by high candle-power multiple or series lamps giving a general illumination. Such systems have decreased the cost of operation by requiring a smaller wattage than previously used, likewise, decreasing in a measure the renewal costs. These lighting units have been placed sufficiently above the moving parts of the machine to prevent handling by the employees. In textile mills where the new lighting systems have been installed, it was found that good light breeds more satisfaction among employees and mill owners than almost any other improvement, as it tends to increase the quantity and improve the quality of production.

In the knitting of silk hosiery specific lighting is required and in one installation visited, this was effectively accomplished by using a 25-watt tungsten filament lamp and reflector over each operator's position, the lighting unit being located 3 ft. above the knitting plane.

Nearly all the different textile industries include inspection and finishing departments where all goods are approved before being packed for shipping. Here, a final opportunity to detect flaws is afforded in order that the quality of the finished product may be maintained. In such cases requiring artificial illumination individual units, placed over each inspection table, are generally employed. An intensity of illumination, similar to that used here, should be applied to the retail stores where those same goods are sold to the trade. The use of high efficiency incandescent lamps has superseded the use of high candle-power lighting units, due to the fact, that the quality and distribution of light is better, and the systems are operated more economically. In the paper-making industry, the general operations necessary to reduce the raw materials to a working condition require only a general illumination of low intensity. At the beating engines in which the raw materials are reduced to a pulp a general lighting of somewhat higher intensity is necessary. Here the pulp may be properly prepared and colored so that it is of the right color and consistency.

*Abstract of a paper read at the annual convention of the National Electric Light Association, at St. Louis, Mo., May 24, 27.

†National Electric Lamp Association, Cleveland, O.

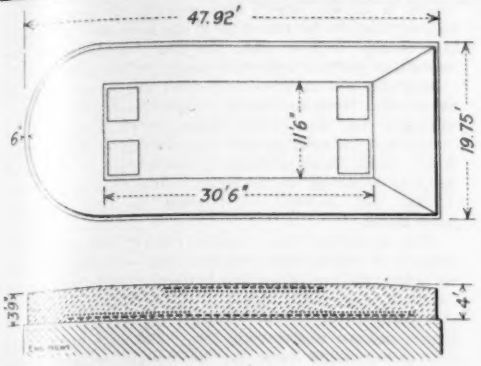


Fig. 6. Sketch of Reinforced-Concrete Capping Slab of Piers.

The lighting in the beater room and paper machine room has been greatly improved from a lighting and economical standpoint by the use of 40 and 60-watt tungsten filament lamps in either glass or metal reflectors. The resulting illumination cannot be called general, although the lighting units have been placed out of reach of the employees and distribute the light so as to give a proper intensity of illumination.

In printing shops (which include engraving, lithographing, typesetting, etc.), the necessity for using the most efficient lighting system appeared so essential that the U. S. Government has tested practically all lighting units in an endeavor to find out which is best adapted to the work. Here, a general system using 250 watt tungsten lamps with prismatic glass reflectors has been adopted. This system was just as efficient from a lighting standpoint and more so from an electrical standpoint, than any other system in use. The application of a general lighting system using 100, 150 or 250-watt tungsten filament lamps with glass reflectors would improve to a great extent the poor lighting conditions at present so general in printing shops.

The manufacture of paints, inks, dyes, rubber goods, toilet preparations, etc., require a general system of lighting, with but few exceptions, such as where close individual work is done. In many of these industries, considerable care must be taken in the matching of colors and the mixing of the ingredients in the correct values to procure definite and fixed results. The majority of paint, ink and dye mixing machines require specific lighting of high intensity.

The various operations of soap manufacture are more or less unskilled and what might be termed "rough work." It is, however, advisable to supply a medium intensity of light. The 60 or 100-watt tungsten lamp is employed for this service and is installed according to a general system of lighting. In dye houses it has been found possible to obtain more consistent results by employing artificial light rather than to depend upon daylight, which varies greatly.

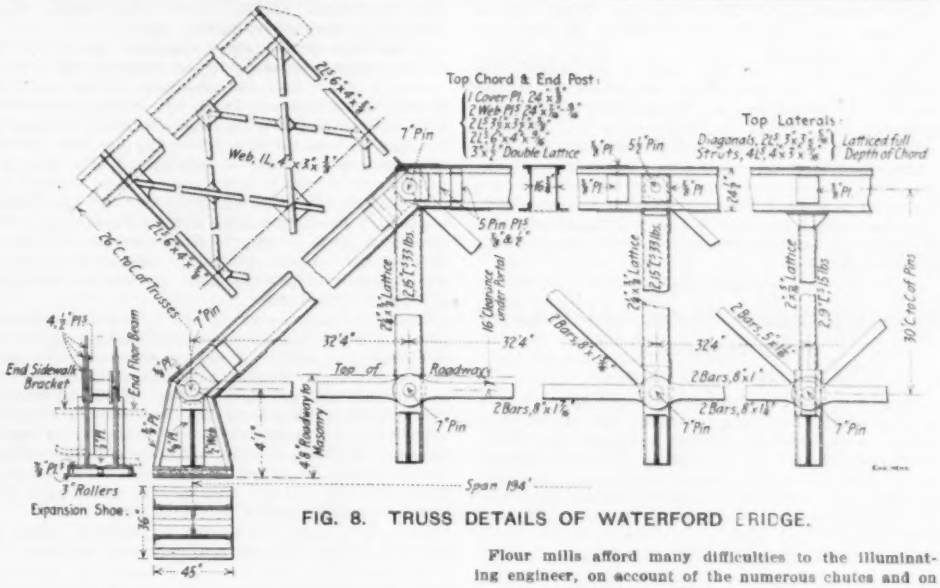
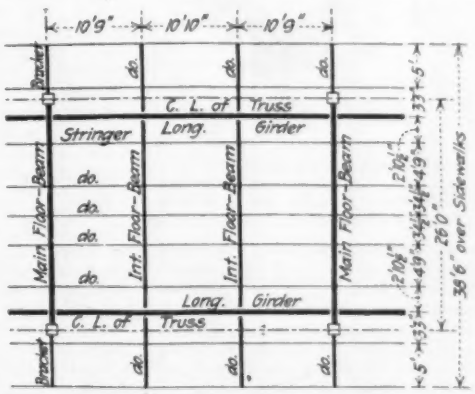


FIG. 8. TRUSS DETAILS OF WATERFORD BRIDGE.

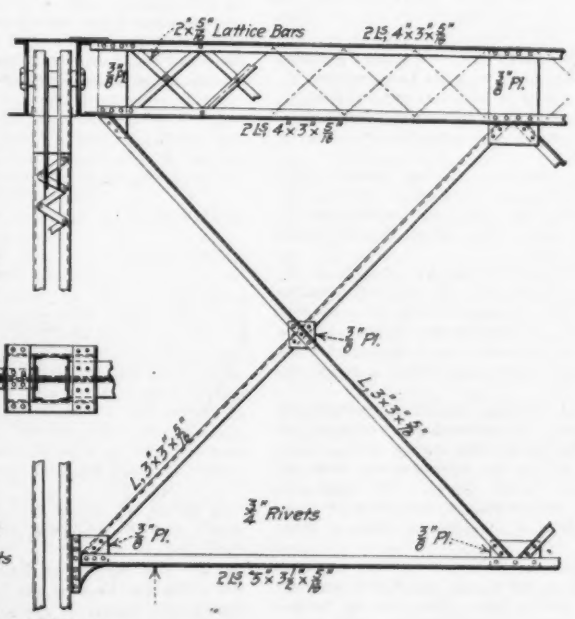
Flour mills afford many difficulties to the illuminating engineer, on account of the numerous chutes and on account of dust which collects upon lamps and reflectors. It is practically impossible to utilize general lighting wholly with marked satisfaction. In the sacking and weighing room specific lighting of a high intensity is required to enable the operator to watch his scales.

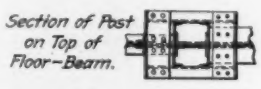
In plants where food products are handled, a high intensity of light is required, not so much to define the operation, as to insure cleanliness. In the plants which came under our observation, it was found that a general system of lighting was employed with but few exceptions.

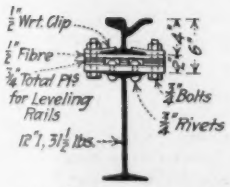
In most of the industrial plants which we have visited, the adoption of new methods of illumination has accom-



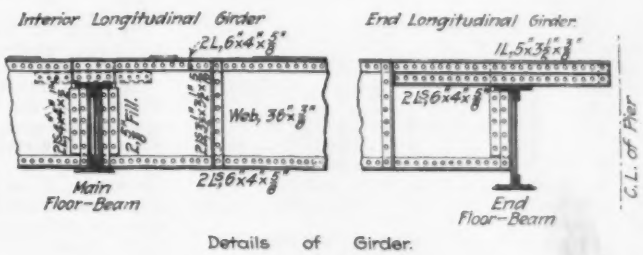
Typical Floor-Framing Plan.



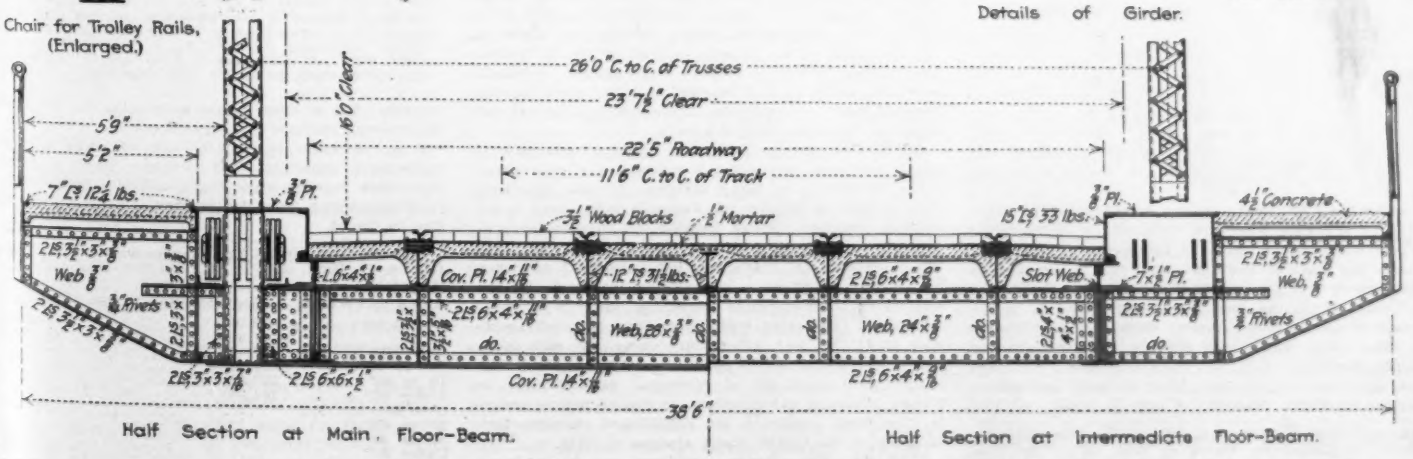




Chair for Trolley Rails, (Enlarged.)



Details of Girder.



Half Section at Main Floor-Beam. Half Section at Intermediate Floor-Beam.

FIG. 7. ARRANGEMENT OF FLOOR MEMBERS, WATERFORD BRIDGE.

plished simultaneously two things: (1) It has reduced the peak load; (2) it has increased the cost per KW.-hr. to generate.

The reduction of the peak load is self-evident. The increase to the isolated plant in the generating expense per KW.-hr. is due to the fact that the fixed expenses have not been reduced in proportion to the load and, consequently, the cost were KW. generated increases, unless there is an opportunity for immediately utilizing the capacity thus liberated. Central stations will find that many such plants are merely waiting for solicitation, since the lighting company is now in a position to offer the industrial consumer power at an attractive, as well as profitable, figure.

Australia's Railway System and Some of Its Problems.*

By JAS. ALEX. SMITH.†

Australia is emerging from the pioneer stage; the time of simply-grasped obvious procedure has passed. The time of issues of great magnitude, of great complexity, is with us. If the potentialities of Australia's boundless possibilities are to be realized—nationally, commercially—railway engineering must be raised from the

Fig. 1. The Railways of Australia.

(Plotted as 40-mile bands, to represent the belt of land within 20 miles of railway. The zone lines parallel to the coast are drawn 100 miles apart.)

minor phase of tactics and technique to its true plane, that of administrative science of the order of statesmanship. For the problems are worthy of the statesman, but the solutions are possible only to the engineer.

Australia has built 16,212 mi. of line: one mile for each 259 of its population; serving (actually), within twenty miles of rail, about 390,000 sq. mi. of territory, about one mile for each 11 individuals. (Fig. 1.)

Britain has 23,100 mi. of line within an area of 121,390 sq. mi.: one lineal mile per 1,934 inhabitants; one square mile per 363 people.

As allocated, Australian railways serve a territory capable of supporting within twenty miles of the rail more than three times Britain's population.

Britain and the United States have one railway gage, Australia has five.

When all Australian territory shall have been brought within twenty miles of the rail, at least 74,000 mi. of lines will have been laid. For what more the future may hold, for the magnitude of the works which may crown the beginnings of to-day, look to the railways of the United States.

AUSTRALIA'S GEOGRAPHICAL POSITION.

Convention is apt to color consideration of Australia's cosmographic relations. As an instance, the Mercator projection is excellent for the ends for which it was planned, but by its distortions of area and position it gives an exceedingly erroneous impression of the continent in regard to the outer world. Apparently separated from congested centers of activity, reached only by long detours from direct lines, the reverse is, in fact, the case.

Change the view point; Instead of accepting the equator as an arbitrary base line, substitute a similar great circle cutting the meridian of Greenwich at 50° N., a little to the south of England. That line is the shortest path between any two points situated in it. Follow the trail east: Beginning just south of England it passes through France, through Central Europe, tracing closely the lines along which rail systems are strengthening towards Southern Asia. It crosses Persia, traverses India, cuts diagonally through West Australia and grazes Tasmania and New Zealand. It extends across the Pacific, intersecting Panama at the canal region, thence returning direct to the starting point.

A relatively narrow belt, symmetrical about that line, contains more populous, civilized, powerful and directly-connected states than any other zone of an equal area of the earth's surface. The points of chief control—the chief links in the connecting lines—are held by the English-speaking railway-building races. In that zone Australia's position is not one of isolation; it is a focal area which must respond to every great change. (Fig. 2.)

AVAILABILITY OF RESOURCE.—The simultaneous attainment of military aims and local commercial ends may seem difficult, but the factors are not incommensurable; and, rightly understood, the underlying law is a law common to both questions. To coin a phrase, it is availability of resource.

Severally, neither area, climatic conditions, population, nor population density affords an adequate standard of effective power. A country may be great in area but unpopulated; densely populated, it may yet be small; large, and densely populated, it may be deficient in transport facilities. By the extent of its utilizable territory; by the sufficiency of the population to secure complete utilization; by the sufficiency of the transport to concentrate utilization, the strength of a people is measured. The standard must be a compound ratio recognising area, population and transport.

Australia is singularly blessed in regard to territory. It possesses very considerable transport facilities. It is lacking in the third factor—population. In that connection, world-relations will force the more intelligent utilization of the means which the railway engineer has already provided.

Internal Relations.

BOUNDARIES.—Australian territory is allocated by state political boundaries. The frontiers chiefly follow—sometimes for many hundreds of miles—imaginary lines of longitude and latitude. They are crudely arbitrary, conforming to no natural law or condition. Artificial as these delimitations unquestionably are, they constitute very real impediments to a homogeneous system of internal transportation.

Each state is a segregated railway entity, segregated by its boundaries, segregated by gage differences, which are a consequence of boundaries. Each state has its own political control, its own organization, its own aims and objects, its own interchangeable rolling stock.

DIFFERENCES OF PURPOSE.—Naturally profound differences of plan and operative mode have resulted.

Queensland's roads penetrate inland as parallel slightly-branched trunk lines feeding a connecting coastal navigation service. Ultimately the connection will be by coastal line.

New South Wales lines fan out from Sydney, with secondary radiations from the main radii. The system effectually isolates point from point, but concentrates the trade of an immense area at the capital, through which all interchange must pass.

Melbourne is the focal point of the Victorian lines. By reason of the inherent advantages of the metropolis as a great continental port, conjoined with the smallness of the sphere assigned, the development is more intense than in any other of the states. As a consequence an intermeshing cross-reticulation supplements a radial reticulation.

The elementary lines of South Australia predetermine no definite after-system. The undeveloped wealth of the great Northern territory awaits the coming of the rail.

The railroadization of the one million square miles of Western Australia has hardly begun. The lines are rather developmental concessions to chance-placed mineral areas than evidences of the commencement of general systems.

Divergence of purpose, or lack of considered purpose, is of lesser moment if states are considered isolated except by capital-to-capital lines. They are of fundamental import if the states are considered as the components of a harmonious whole. Viewing the states as integral parts of an ultimate railway entity, it is clear that unless correlation of the larger efforts is sought now the condition will be chaotic later, when the accomplishment of complete intercommunication at all points is forced by natural growth.

LOCATION.—In the light of a manifold assurance of great resources, of continued progress, and of a population increasing to many millions, all that has been done is open to revision, all Australia is yet open to the railway engineer. Sound location—all location not admittedly ephemeral—must be based upon standards which ensure, not transitory, but permanent efficiency and economy. There is no avoiding the issue, for the underlying, ever-operative correcting force is gravitation itself. For every error of position, for each avoidable grade, for each unnecessary curve, for each inappropriate speed, a toll in perpetuity will be exacted. The nature and magnitude of revisional work sequent to phases of limited capitalization, or limited mental grasp, is illustrated vividly in the enlightened reconstruction of many of the United States systems of lines.

CLIMATE.—The climate conditions are favorable to railway engineering. They close no portion of the continent to railway effort; they simplify the labors of location; they render but little of the total area inhabitable unprofitable railway area, provided the connection between the products and environment is duly observed.

Australia is a snowless land; thus the railway engineer is relieved from the heavy constructional and working expenses that snow accumulations entail in many countries.* A simultaneous consequence is that in lieu of artificial conservation of rainfall less run-off a substitute must be found by the irrigation engineer for the natural storage and distribution of water by slowly melting snow-fields.

Duly conserved, that wasted run-off, conjoined with the warmth of climate—that manifestation of thermal energy by which all life exists and thrives—contribute natural assets of incalculable value.

In many cases, in new country, the work of the irrigation engineer has this relation to the work of the railway engineer—the water can be brought to those areas best suited to the rail as conveniently as the rail, to reach independently determined irrigated sites, can be taken to less suitable railway country. Gravitational water flow may thus, in effect, supersede steam haulage with its inherent costs.

OCEAN FRONTIER.—Australia's frontier to the world is the ocean. At that frontier all international exchanges must be made—the sole idea in mind when the early railways planners drove the lines inland from the coastal settlements. The trend to concentrate traffic at maritime metropoli, without full recognition of the possibilities of inland centers and their allied cross-connections, has continued.

But, inherently, the coastal influence must always be prepotential in the work of location. It permits the linking of terminals by an unbroken closed curve of circumnavigation. No other country of equal area possesses this island advantage. In Europe, Asia, or the Americas there is but one coast, or coasts widely separated. The matter marks a basic difference in the general system suitable for those lands and for this, and it marks a great natural advantage to the Commonwealth.

The beginnings of a connecting, closed curve of rail exist in the Eastern states; its extension is but a matter of time. In paralleling the many thousands of miles of undeveloped coast, a multiplicity of new maritime concentrating points must come into existence. Unless anticipated in position and provided for in location, these foci would exercise a grave effect upon any general scheme which fails to provide for them. Not merely a

Fig. 3. The Australian Railway System in Relation to the Area of the United Kingdom.

(The smaller square is the sum of the 40-mile railway bands of Australia, the horizontal parallel lines indicating the railway lines at 40-mile spacing. The outer square represents the area which Australia's railways could serve, on the same 40-mile basis, if there were no superposition, as occurs near crossings.)

courtesy, but a close formal association of the harbor and railway engineer is foreshadowed.

It is convenient to consider internal areas as zones, conforming, generally, with the coast line. A distinct connection between such bands and the meteorological conditions which make for uniformity of production can also be traced.

*By the courtesy of the Commonwealth Meterologist (Mr. A. H. Hunt, A. V. I. E.) the following comparison is possible:

AREA BETWEEN MEAN TEMPERATURE ISOTHERMS.

Isotherm.	Australia, sq. miles.		Canada, sq. miles.
Over 80° F.....	422,100		
80° to 70°.....	1,521,000		
70 to 60°.....	927,000		
Under 60°	104,500		
Over 40°	....	.....	292,300
40° to 30°.....	....	.....	711,000
30° to 20°.....	....	.....	1,114,600
Under 20°.....	....	.....	1,501,918
Total Australian	2,974,000	Total Canadian.	3,619,818

*Extracts from a Presidential Address to the Victorian Institute of Engineers, March 9, 1910, under the title "National Issues in Australian Railway Engineering."

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A point deserving of note, which, it is believed, has not been noted, is the effect of an undue number of junctions in pioneer work designed to serve the greatest area by the least length of rail. For instance, assume that the Australian roads had been extended as single lines solely with pioneering in view. They would have served 650,000 square miles of country within 20 miles of rail. They actually serve about 390,000 square miles. One of the chief reasons of this great discrepancy is that each cross-junction implies the loss, in this relation, of an equivalent of 40 miles lineal, or 1,600 square miles, of such a railway band.

Calling the developmental efficiency of single, straight lines 100%, the Australian lines, as a whole, have an efficiency of about 60%.

IRRIGATION.—Zonal functions lie very close to the basis of general plan, but there are influences, chiefly topographical and productive, which justify or require local modifications. For instance, much present and prospective freight may be viewed as solidified rainfall. The gathering area is, broadly, the area of the water availability, and as a generalization, the heavy freight flow is unidirectional, coastward, and is governed by the location of the river systems where these exist.

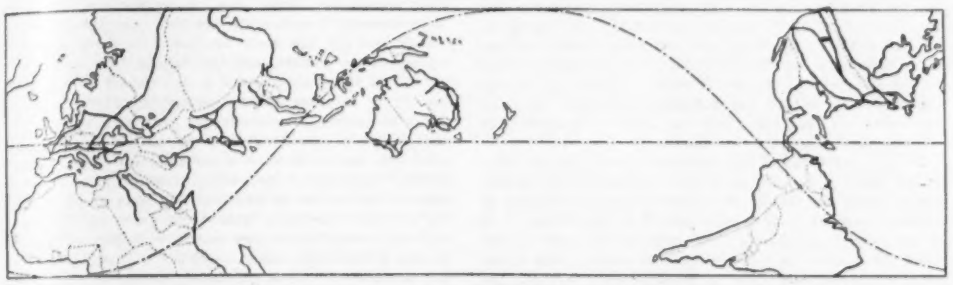

FIG. 2. AUSTRALIA'S GEOGRAPHICAL RELATION TO THE WORLD.

(Cylindrical projection, whose central line is a great circle through the English Channel and the Isthmus of Panama. The curved line is the equator. Some main railway arteries are indicated.)

In this climate the relation of the rail to the stream is complex. Water is the prime need; it is not over-abundant without conservation, and its value is therefore enhanced. When the value of the water for irrigation uses exceeds its value as a mode of transport, and when the flow is not simultaneously available, as by locking, for both uses, then the construction of river-valley lines, with easy grades, is indicated. Most existing railways meet the streams, tap them, but do not follow them—a plan depending upon the fashion of a time anterior to recognition of the imperative necessity for the full use of all waters for irrigation.

Obviously the questions of irrigation and railway minor location are intimately connected.

RULING GRADES.—More than any other individual item, often more than all other engineering factors, grade is a determinant of first cost and working expenses. Grades of 1 in 50 and 1 in 40 on main trunk lines are a heritage from the past to us. There were, usually, no physical reasons why more favorable grading should not have been attained. The reasons were reasons of transient expediency. Where they operate, such grades are multiplying haulage charges fourfold, and more than fourfold. There is no engineering doubt that, in national development by lines destined to become main lines, heavy revenue-crippling grades should be rigidly discouraged.

TOPOGRAPHIC DATA NEEDED.—In the wider generalizations, the engineer in Australia is at a disadvantage. His contemporary abroad has to deal with settled communities, which have through the centuries found their lines of transport. He has recorded and traditional knowledge of flood-levels and other essential matters; also he has in ordnance and similar surveys extremely accurate collated information in regard to the conditions of every possible, prospective route. Here there are no such guides. Sufficiently-complete topographical surveys are matters which cannot be too early undertaken in order that the after engineering of surface conditions, military as well as civil, may be carried out with clear judgment. It is necessary also to bear in mind that the rail must be so placed that, if possible, the main highway grades are moderate also. This provides another argument for anticipatory topographic survey.

UNIFICATION OF GAGE.—Difference of gage absolutely precludes unfettered inter-state interchange.

In construction, given gage uniformity, great economies would result. Instead of many stocks of differing sections, and differing adjuncts, the standardization of stocks, their reduction, and a reduction in the dead capital they represent would follow.

TIMBER RESOURCE.—Afforestation is not a function of the railway engineer; but enormous calls will be made upon the already depleted forest areas for future railway extension and sleeper and structural renewals. That the supply may be cheap and plentiful, forest conservation is an essential, and an immediate essential.

From this brief and incomplete summary of the components of the policy of location it may be gathered that the details are numerous, and far beyond matters for mere routine treatment.

It will be gleaned that prescience is the quality to be cultivated; for there is choice between national efficiency and local efficiency, between cheap construction and complete construction, between apparent economy and true economy.

FUEL RESERVES.—The whole future of Australian internal communication is a question of the adequacy of the coal beds. There is no question of the sufficiency of the present coal in sight to meet for hundreds of years requirements on the basis of present consumption. There is every probability that other coal measures will be found. Great though the known supplies are, they are not inexhaustible. Britain's annual output would exhaust the one-thousand million tons of the great New South Wales basin in four years.

ENGINEERING FINANCE AND ADMINISTRATION.—In private railway enterprise keen rivalry—or the possibilities of rivalry—compels equally keen, responsible internal criticism, until results at least equal those of competing or parallel undertakings. Read in the light of the knowledge that effort is as effective as close interested censorship can make it, a comparatively simple return giving prominence to capital invested and net return, and giving lesser prominence to intermediate processes, suffices. It is no part of a private undertaking's policy to, in fact, disclose its methods of operating.

Something more is requisite in the case of the control of national engineering interests. There is no competition. Continued responsibility is absent. Questions of general policy blend with questions of railway policy, and only the initiated can discern the intent. In so far as railways are organized engineering, in so far is it necessary that all material permitting the comparison that replaces—in a degree—competition, should be presented, and in a comparable form.

Excluding the value of lands dedicated by grant, the capital value of the Commonwealth railways was in 1908 £139,988,015. The net earnings equalled 4.22% or 0.58% more than interest on loans. Such figures are satisfactory from a bondholder's point of view. But they do not differentiate between engineering charges and taxation rates. Neither does a statement of the ratio of expenses to revenue earned make this clear. The ratio may be the same if economy is coupled with low rates, or if inefficiency is connected with proportionately higher rates.

The "train-mile" purports to furnish a standard. It is, in fact, but an arbitrary convention of limited application in older communities of constant condition or slow change. As an Australian standard it would be fallacious. Each increment of locomotive power gives a new value to the unit, therefore it fails conclusively in the comparison of differing periods or of differing systems. It does not discriminate between train weights or train speeds. It does not effectually discriminate between gage differences; in fact, if gage difference is not specifically indicated, a fictitious equality is attached to widely differing quantities. (Obviously a train-mile on a 3-ft. and a train-mile on a standard-gage line are very different things.) It gives no hint as to the relation of paying load to dead load. It does not disclose the efficiency of location or traction.

The fully acknowledged "passenger-mile" or "ton-mile"—that is, one passenger, or one ton hauled one mile—is far more crucial. The resulting total cost of hauling unit weight over unit distance is a definite expression. It is the total in which all antecedent factors merge. It is a summation, in comparable form, of the effects and efficiency of location, construction, traction and administration.

In national railway issues the importance of selecting a definite, constant, comparable equivalent of the constructional and operative efficiencies is unquestionable.

The statistical convention of differentiating between state and private railway capital presents Australia's position for popular comparison abroad in an unjustly unfavorable light.

Australia adds its Government railway capital to "debts."
Canada adds its private railway capital to "wealth."
Adding Canada's railway capital to its "debts" the total amount is..... £312,387,161
Adding Australia's railway capital to its "debts" the total amount is..... 243,335,487
The usual statistical statement of debts reads thus:

Australia	£243,335,487
Canada	78,104,292

PROMOTION OF SETTLEMENT.—The greater administrative function, depending for completeness upon the unison of engineering and statesmanship, is the provision of access to the land, and provision of settlement of accessible territory. Access provided, not too quickly, else will the immediate burden be too great; not too slowly, else will the work of development be chilled, the potential capital lie dormant, perhaps to pass to others.

Canada has grasped the duality of the situation, and is profiting. Its lines are, principally, privately owned. The capital is held at centers which control the immigration streams. The climate is rigorous. But, apart from higher reasons, as a business proposition the streams of population have been diverted to those areas where, whilst advancing their own interests, the emigrants also become dividend-earning forces. The effect is reflex; once started persisting, and increasing at compound interest rate; the people creating the possibilities of further rail extension, the extension which the people create permitting of further population.

There is in Australia no railway sodality which ensures unity of interest and endeavor in those affairs which so profoundly affect the bases of engineering design. Each state has its own railway jurisdiction, its own local management, its own limitations. It cannot be held that the units shall always remain segregated and segregating railway entities.

CENTRAL DIRECTION.—It is clear that there must evolve a connecting organization, a body exercising the higher engineering functions; a body competent to judge, to suggest, with the power to ensure that the suggestion shall be a materialization of the best available knowledge; a body competent to determine questions of engineering economy; a body with machinery to ensure that economies are not pushed to the point when they become menaces to public safety.

So far Australia's efforts have resulted in six machines. The attainment of the completer specialization, the coordination of the parts of the six machines as a whole for the achievement of joint purpose, the crystalizing of a supreme connecting controlling intent is the great work of the future, a work in which the engineer must bear a heavy part, for in his hand rest the lives of the people, the destiny of a continent.

The Mechanical Preparation of Coal.*

By H. H. STOEK.†

The mechanical preparation of coal refers to the treatment to which such fuel is subjected in order to prepare it for use. This preparation includes sizing, washing, coking and briquetting.

In considering the mechanical preparation of any mineral two facts must be determined: (1) Does the material as it comes from the ground require mechanical treatment or preparation to render it usable for commercial purposes? (2) If mechanical treatment is not absolutely necessary, will such treatment increase the value of the material sufficiently to compensate for the cost of the treatment? The possibility of improving the fuel value of a given coal by mechanical treatment depends upon the physical conditions and chemical composition of the coal.

The parts of the composition that have a fuel value are the fixed carbon and a certain part of the volatile matter. The moisture and ash have no fuel value, while the ash means also increased cost for handling after the coal has been burned. Experiments made by Mr. W. L. Abbott, Chief Operating Engineer of the Commonwealth Edison Co., of Chicago (Journal of the Western Society of Engineers, 1906), indicate that for each coal there is a certain percentage of ash which limits the value of the coal for a fuel and determines the temperature attainable for such coal. In the experiments noted this was from 40 to 45%. In commenting on this experiment, Mr. Abbott says:

> The fact should be emphasized that although over half of the composition fed to the fire was fuel, it burned without producing any useful effect. For this there are two reasons: (1) On account of obstructed air supply through the fuel bed, incomplete combustion and escaping hydrocarbons carried away a portion of the heat, because the gases passed immediately among the tubes of the boiler; (2) owing to the presence of an excess of ash, the percentage of fuel on the rear portion of the grate is greatly reduced. On this account a larger proportion of the air passing through the fuel bed does not combine with the fuel, but enters the furnace as free air. As the prime function of a furnace is to heat

*Abstract of a paper read at the annual meeting of the International Fuel Association, held at Chicago, May 23, 26.

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the gases passing through it, any increase in the amount of air entering the furnace without a corresponding increase in the amount of fuel burned must result in a lowering of the furnace temperature.

This lowering of temperature, besides making a long, smoky flame which reaches up among the boiler tubes and is there chilled to below the burning point, also reacts on the fuel bed, reducing the rate of combustion and still further increasing the adulteration of the furnace gases with free air. When the temperature of the furnace has been reduced to about 600° F. the boiler is unable to absorb any more heat than is necessary to make up for radiation losses.

The amount of sulphur is usually small and the fuel value of the coal is not materially affected by its presence. The sulphur, if it oxidizes when the coal is burned, has a certain fuel value, but this is more than offset by increased clinkering and the injurious effect of the sulphur upon the grate bars. Consequently sulphur may be considered as a wholly deleterious element. Phosphorus occurs in very small quantities and may be neglected excepting in connection with the manufacture of coke for use in the blast furnace. The presence of sulphur or phosphorus in coke intended for the manufacture of iron is very detrimental and the amount of these elements in the coal may constitute the determining element as to whether a certain coal can be coked commercially (or will have a sale after it is made). The removal of the sulphur is therefore one of the chief problems in the mechanical preparation of coal intended for coking. Phosphorus cannot be removed mechanically.

The mechanical treatment of coal aims (1) to size it so that it may be burned to better advantage; (2) to increase the relative amounts of fuel constituents (fixed carbon and volatiles) by decreasing the non-fuel elements (such as moisture and ash); and (3) to decrease the deleterious elements (sulphur and phosphorus).

SIZING COAL.—For many years, the only treatment to which bituminous coal was subjected was to dump it over inclined bars which separated the very fine material called slack from the lump coal and in many cases even this amount of screening was not done and the coal was shipped run-of-mine. Although this method still prevails to a considerable extent, a large amount of bituminous coal is now sized and some of the tipples recently built contain appliances for separating seven or eight sizes.

The object of sizing coal is to secure a product that can be burned more advantageously than unsized coal. A compact coal that contains but little volatile matter burns on the surface and the combustion extends gradually inward. Hence it is advantageous to have lumps of approximately equal size so that the air can reach the surface of the coal as uniformly and as readily as possible, for if large and small lumps are mixed, the passageways for the air between the large lumps are stopped by the small lumps.

It is not practicable to size very soft coals, such as Connelsville or Pocahontas, and, moreover, there is not the same necessity since the coking in the furnace soon destroys the effect of the sizing. However, even with such coals, a large lump mixed with fine coal will lie practically dead for a long time and must be broken up in the furnace to secure the most effective burning. Anthracite is systematically broken by rolls in order to produce the sizes for which there is the best market, but thus far, there has been very little breaking of bituminous coal in order merely to size it for fuel purposes to supply a demand for certain sizes. Coal is, however, crushed before coking and is broken and sized before washing to secure the best results. The time may come when bituminous coal will be broken to secure certain sizes just as is done with anthracite; in fact, certain tipples recently built have crushers installed for this purpose looking toward the necessities of the future.

The sizing of coal is done in one of two ways: (1) by inclined bars; (2) by screens, which may be revolving or shaking.

In the agreement between the coal operators and the United Mine Workers, the standard screen is a series of inclined bars over which the run-of-mine coal is dumped. These screens separate the lump from the slack or screenings. The agreement in regard to these screens made in 1898 and generally still used in the territory specified is as follows:

> Screens hereby adopted for Ohio, western Pennsylvania and the bituminous district of Indiana shall be uniform in size, 6 ft. wide by 12 ft. long, built of flat or acorn-shaped bars of not less than ⅝-in. surface, with 1¼ ins. between bars, free from obstructions; and such screens shall rest upon a sufficient number of bars to hold the bars in proper position.

Excepting for the sizes prepared on these standard bar screens, there is a wide variation in the sizes of bituminous coal in different localities and there is no uniformity or standard in regard to either names or sizes in different states or even in different parts of the same state.

In Illinois, where washeries are not used, many mines have rescreening plants. The coal is usually first run over shaker screens to take out the smaller sizes of coal, 2 to 3 ins. diameter. The coal passing over these perforations is marketed as egg and lump. The smaller coal is elevated, passed through a revolving screen and usually marketed in three or four sizes. When in four sizes they are usually slack up to ¾-in.; pea, ¾-in. to 1-in.; No. 2 nut, 1-in. to 1¾-ins., and No. 1 nut, 1¾ ins. up to whatever size is elevated (usually from 2½ ins. to 3 ins., or even 3½ ins.). The rescreened sizes vary somewhat, depending on the largest size of coal that is elevated; that is, all of the rescreened sizes would be slightly larger than those given if 3½-in. coal were elevated and they would be somewhat smaller if 2-in. or 2½-in. coal were elevated.

It is claimed by some operators that rescreened coal burns better than that which is not rescreened, for the reason that in the rescreening, the lumps are rounded and the edges knocked off, thus giving a more uniform product which will burn more regularly than that which has the sharper edges.

Illinois has not only taken the lead in the screening and marketing of unwashed coal, but is also the leader in the washing of coal for steam and fuel purposes. The practice in regard to the screening of washed coal in Illinois is quite largely followed in the few washeries built in other neighboring states where washing is done for steam and fuel purposes. The washeries in these states commonly prepare five sizes of coal, although some few prepare only three and a few washeries prepare seven. Where the five sizes are made they are numbered as follows: (1) 3-in. to 1⅝-in., (2) 1¾ to 1-in., (3) 1 to ¾-in., (4) ¾ to ¼-in., (5) ¼-in. and smaller. These last two sizes have to be separated by the use of a spray of water on the screens. In fact water spray is often used on the sizing screens for all the different sizes as it not only facilitates sizing, but gives the coal a brighter and cleaner appearance for the market.

CLEANING COAL.—The cleaning of coal should begin in the mine, and as far as possible the impurities be separated there by hand, thus decreasing the amount of useless material hauled and hoisted to the surface. It is not always possible for the operator to secure in the mine the amount of cleaning that he desires, and moreover, with the poor light it is impossible to clean the coal as thoroughly as can be done on the surface. But in many cases coal could be much better cleaned at the face than it is.

At present over 50% of the coal mined in the United States is shot off the solid, and even where the coal is undercut by machines an excessive amount of powder is used. Solid shooting, too much powder, and payment on the run-of-mine basis result in an excessive amount of fine and dirty coal, and complicate the coal cleaning problem of the mine operator. The amount of ash in the coal marketed may be materially increased by improper mining for not only is more fine coal produced by solid shooting and the excessive use of powder, but the coal is thrown from the face and so scattered that in loading it into the mine car a larger amount of dust and dirt from the bottom is gathered up than when the coal is properly broken down.

In the preparation of anthracite, the pieces of slate or bone are separated from the coal after it has been sized by men or boys sitting in the chutes down which the sized coal runs to the pockets, or else by automatic slate pickers. This is not ordinarily done with bituminous coal, though occasionally a few men or boys stand along a chute and pick out the slate or else the coal is conveyed to the pockets by belts beside which stand men or boys who pick out the slate, and in a few instances automatic slate pickers are used. In some districts the only separation of slate at the surface is made while the railroad car is being loaded by men in the car who throw out the pieces of slate.

COAL WASHING.—The principal method of purifying bituminous coals is by washing. The technical meaning of coal washing is a separation of impurities from the coal due to a difference in the specific gravity, and it does not mean merely a washing off by a spray of water of the mud or refuse adhering to the surface, although this latter use of the term sometimes is found.

The object of washing coal is two-fold: (1) To reduce the amount of ash in the coal intended for fuel purposes and thus to increase its fuel value. In doing this the amount of sulphur is also reduced, although this is not particularly a consideration, and for this purpose alone washing would not be carried on when the coal is intended for steaming or domestic purposes (except on a comparatively small scale to produce a blacksmith coal). (2) To reduce the amount of sulphur in a coal intended for coking so that a coke can be made which will be usable in the manufacture of iron. At the same time a certain amount of ash-producing impurities are removed, but the prime object is usually the removal of the sulphur.

Washed coal does not contain as much dust as unwashed, and the presence of dust has been shown to be a disadvantage in burning coal as it clogs the air passage between the lumps of coal and thus interferes with combustion. It also adds to the smoke problem. The dust and the sludge obtained in the washing of coal are, however, often very high in carbon and the large amounts escaping from any anthracite coal breaker and many bituminous tipples may some day be utilized for briquettes. One laboratory experiment along this line has already been inaugurated and the briquettes are on the market in competition with anthracite.

Coal is a comparatively cheap material that must be handled in large quantities, quickly and at a minimum of expense. Hence, while the same general principles apply to the washing of coal as to the concentration of ores, the selling price of coal will not usually permit the cost for equipment or treatment that is possible with the more valuable ores. The principle underlying all coal washing machinery depends upon the difference in specific gravity between coal and the impurities mixed with it. The average specific gravity of coal and of the materials which must be considered in connection with the washing of coal are as follows:

Coal.	
Anthracite	1.5
Bituminous	1.25 to 1.35
Ash Forming Impurities.	
Shale	1.60
Slate	2.10
Fireclay	1.90
Sulphur Sources.	
Iron Pyrites	4.2
Calcium Sulphate	2.32

If a mixture of pieces of coal, slate and pyrites of approximately the same size be agitated in water and then allowed to settle, the heaviest (the pyrites) will go to the bottom, the next heavier (the slate) will settle on top of the pyrites, and the lightest (the coal) will be on top of the slate or may even float off on top of the water. It is often difficult to specify what is coal and what is refuse. For instance, coal with only 2% ash may have a specific gravity of only 1.25, while coal with 8% ash will have a considerably higher specific gravity (possibly 1.35), while another piece from the same mine containing 20% ash may have a specific gravity of 1.45. The same wide variation in specific gravity will be found in the rock mixed with the coal and the values given in the table above are only approximations.

A piece of coal 1 in. diameter, a piece of slate 1 3/16 ins. diameter and a piece of pyrites 3/32-in. diameter will weigh the same, and falling in water will settle in about the same stratum. If there is this difference in the relative sizes of the pieces of the three materials there will be little or no separation of them. The more nearly the particles of the different materials are of the same size the more readily can they be separated.

If it were merely a question of separating pure pyrites and pure slate from pure coal the problem would be comparatively simple, but it must be borne in mind that the slate merges gradually into bone coal, and the bone coal in turn merges gradually into coal, and these may be mixed in any proportions. Furthermore, pyrites instead of being pure and occurring in lumps or balls by itself, may be finely divided and mixed throughout the coal. In this case, a separation by washing is practically unattainable.

It is usually necessary to establish an arbitrary distinction between coal, bone coal and slate; for instance, to call everything coal having a specific gravity of less than 1.35, everything between 1.35 and 1.45 or 1.50 bone coal, and everything having a higher gravity, slate. The market varies widely in what it will accept; when the demand is brisk almost anything black will pass for coal, while when the market is not brisk, the purchaser may be more particular about what he gets.

Coal is broken preparatory to washing it in an ordinary toothed roll, and then sized either in revolving screens or shaker screens, or in an hydraulic classifier. Machines used for washing coal are classed under four general heads: (1) Trough washers, of which the Scaife is an example; (2) inverted cone washers, like the Jeffrey; (3) bumping tables like the Campbell; (4) jigs, of which there are a large number of different types.

The Scaife washer consists of a semicircular trough about 2 ft. in diameter and 24 ft. long, set at an inclination and containing a number of partitions, the height of which can be made greater or less as desired. A number of arms are attached to a shaft which runs the entire length of the trough, and these are given a reciprocating motion by means of a driving pulley at the center. The mixture of coal and water is fed into the trough at the upper end and it is stirred by the arms as it flows downward along the trough. In this way any mud is washed from the coal and the coal and slate are kept stirred up, the slate and pyrites settle behind the dams or partitions, while the coal flows over the end of the trough. A washer of this size handles from 75 to 100 tons of coal per day, and one man can attend to six washers. The principal advantage of this washer is the low cost of attendance, and the small amount of power required, 1 HP. being required for each washer.

The Jeffrey-Robinson washer consists of a steel inverted cone chamber in which are arms and stirring plates. A water supply enters at the bottom and the coal through a chute at the top. The arms agitate the mixture, and the coal being lighter flows out over the top through the chute upon conveyors, which are perforated, so that the water drains off the coal as it passes over the conveyors and before it is dropped over

the head into the chutes. The waste material being heavier than the coal, sinks to the bottom of the cone, and is drawn out from time to time through the bottom by means of two gates. The water which drains from the coal on the conveyors can be used again by being pumped from the tank back into the washer, but water should be used over again in this way only when it is absolutely necessary, as the sulphur in coal becomes finely powdered and floats on the water.

The Campbell bumping table consists of a shallow rectangular box about 9 ft. long by 3 ft. wide suspended by rods. One end is provided with a solid head and bumper, which is shod with a steel plate, and the bottom is carved and consists of an upper or false bottom, and a lower or permanent bottom. By means of a ram or eccentric the table is shaken or bumped, and in this way the heavy slate and pyrites gradually separate and go off the end of the table, while the coal being lighter goes off the other end of the table. This method corresponds with the use of the bumping table in the concentration of ores.

The jig is the most commonly used appliance for subjecting a mixture of coal, bone and pyrites to the intermittent action of a rising current of water. Jigs are of two general classes. (1) Fixed screen jigs in which the material rests on a fixed screen and the pulsation of water is produced by a piston moving up and down, or back and forth, in a compartment below or at one side of the screen compartment. It is evident that as the water is forced upward through the screen the mixture will be stirred up and separated or shaken apart, and then, as the water comes to rest at the end of the upward motion of the water, the materials will arrange themselves according to their specific gravities as already explained. The mixture to be jigged is fed on the upper side of the screen away from the discharge opening, and as the pulsations continue this material gradually works its way towards the outlet or discharge, the stratification or separation of the materials becoming more and more perfect as the material travels from the feed to the discharge side of the screen. The length and number of strokes of the jig depend upon the material to be separated. The heavier the material the greater the force it is necessary to apply in order to stir up the bed.

(2) Moving pan jigs, in which (instead of the agitation being produced by the movement of a piston) the pan may be hinged at one side and hung from the other end by rods which are attached to some form of gearing above and caused to move up and down, thus producing exactly the same effect within the pan as is produced by a piston in the piston type of jig. The Stewart and Pittsburg jigs of this type have been extensively used in the preparation of bituminous coal.

In both the piston and pan types of jigs the refuse is drawn off at the bottom and from one side of the pan, while the washed material flows out over the top or is taken off by means of a conveyor. The Feldspar jig or Hartz jig has a layer of feldspar on the pan and the fine refuse material passes down through this bed of feldspar and through the openings in the screen into the bottom or slush tank of the jig from which it is drawn out through openings.

Where the materials to be separated are very close in specific gravity it is often advantageous to use a double or triple compartment jig, which is practically two or three jigs run in tandem. The first jig takes out the rock and allows the coal and bone to go into the second jig where it is treated entirely similarly to the first jig and a separation of the coal and bone is made. This is an adaptation of the method of jigging which is largely used in connection with ores.

The cost of washing coal varies widely in different localities, and in Illinois alone, figures have been furnished the writer varying from 2½ to 20 cts. per ton; but many quote their costs as simply the labor employed in the washing, without including the interest on their investment and the depreciation of the plant. A cost of 10 cts. per ton will apply in a number of Illinois plants.

Until quite recently, the coal washing industry in the United States could be said to be in an experimental state, owing to the fact that there was such a great amount of high-grade coal in the Appalachian and other coal regions that could be marketed and coked without preliminary washing. As the coal fields have been more extensively developed, and as competition between districts has become more keen, and also since the Connelsville region is being rapidly exhausted, the demand for washed coal both for domestic and coking purposes, has increased. Another item which has given an impetus to the coal washing industry is the extensive introduction of late years of by-product coke ovens. The use of these ovens renders it possible to coke coal which cannot be coked in the bee-hive oven. It has also been demonstrated that it is possible to coke certain coal after washing which cannot be successfully coked before washing, on account of the large amount of impurities contained. The low-grade coals of the Rocky Mountain states can be greatly improved by washing and many of them can be coked only after first being washed.

The amount of the coal washed and the number of washeries in 19 states in 1908 are shown in the report of Mr. E. W. Parker as follows: Number of jigs or washers, 682; coal washed, 13,660,478 tons; coal obtained, 11,870,438 tons.

Illinois is the chief center of coal washing for domestic purposes. In Alabama, the coal is washed mainly as preliminary to coking, and in Pennsylvania it is washed both for coking and domestic purposes. There are a few washeries in Montana and Washington, where the coal is washed for railway use, although thus far there has not been much demand on the part of the railways for washed coal.

Not all coal can be washed successfully or economically, and coal washing is by no means the panacea for all the ills of the coal market that some enthusiastic advocates would have us believe, but that the industry has a future and that the problem is worthy of the closest study of engineers we are assured. It must be borne in mind that each coal washing proposition is a distinct problem, and that there is no universal coal washing process or machinery. Each problem must be separately studied and extensive laboratory tests made before an expensive plant is erected, for by such examinations and tests it is generally possible to say whether a certain coal can be washed and thereby rendered fit for a specific purpose.

COKING COAL.—The coking of coal is too extensive a subject to be considered in detail here. Until recently, the coking industry has been of interest almost entirely in connection with the manufacture of pig iron, and the lesser use of coke in the foundry. The introduction of by-product ovens, however, has given an interest in the subject to many connected with mechanical pursuits because most of these by-product plants are located in large cities and many of them have been established with a view to utilizing for fuel or illuminating purposes the gaseous products which are wasted in the ordinary bee-hive oven. A few of these plants have been established for the purpose of providing coke for domestic use and in connection with one at least (at Everett, Mass.) it was thought that the coke would be used extensively by the railways of New England. This experiment, however, does not seem to have been very successful. In connection with the smoke problem in Chicago, experiments have been made by the railways in connection with the use of coke made from Illinois coals, but there is no data available at present in this connection.

BRIQUETTING COAL.—The briquetting of coal has been exhaustively treated before this association by Mr. C. T. Malcolmson, and need not be here considered.*

Concrete Conduits for Electric Cables.

The use of concrete conduits (cast in place) for electric cables laid in streets was described in our issue of June 9, in a paper by Mr. S. B. Way, Superintendent of the Union Electric Light & Power Co., of St. Louis, Mo. Since this was published we have received from the Monolithic Conduit Co. (Chemical Building, St. Louis, Mo.) some further particulars of this system of construction, together with illustrations of the work. The methods of construction were given in the article mentioned above, but it may be explained here that U-shaped wooden forms for the ducts, in 16-ft. lengths, are placed upon concrete supports (16 ft. apart) standing on the graded bottom of the trench. Concrete is then filled around the molds, level with their tops, and after the molds are removed the conduits are covered with ⅝-in. concrete slabs. With more than one row or tier of conduits, the next row is cast in the same way upon the top of these plates.

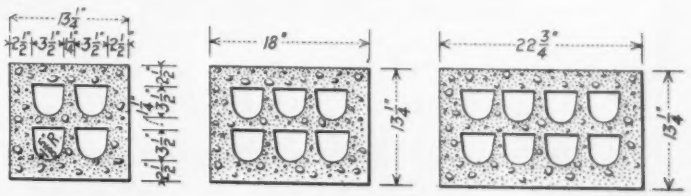


FIG. 1. SECTIONS OF CONCRETE CONDUITS MADE IN THE TRENCH.

Fig. 1 shows some of the sections of the conduits, and the accompanying table shows the amount of concrete required. Fig. 2 shows the longitudinal forms or duct molds (A) in place for a four-duct conduit; they rest on the block (B) and are held in place by weights (C). Fig. 3 shows the completed ducts with the ⅝-in. concrete cover slabs (D) being placed, ready for the construction of another tier of ducts. These slabs are 20 × 24 ins.

The system is the invention of Mr. S. B. Way and Mr. E. C. Freeze, and its construction was

*Engineering News, Aug. 5, 1909.

FIG. 2. MOLDS IN PLACE FOR THE DUCTS OF CONCRETE CONDUITS.

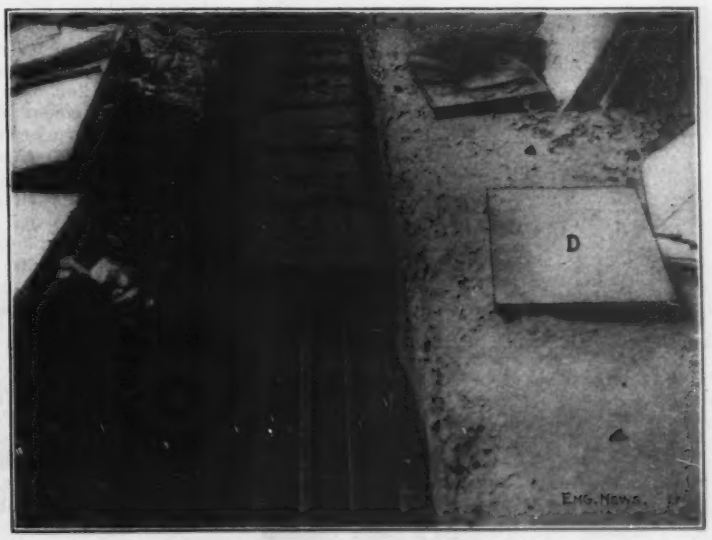


FIG. 3. CONCRETE DUCTS COMPLETED AND BEING COVERED WITH CONCRETE SLABS.

commenced in St. Louis in 1906. The company has built about four miles of conduit, with an average section of eight ducts. It is claimed that by this construction the cost of tile or pipe ducts is saved, as the latter require practically the same amount of concrete, while the work is simplified by eliminating the transportation, handling and laying of tile or pipe. The strength is considered to be greater for the concrete system, while its maintenance cost is very low. No defects or failures have occurred in the 3½ years' service.

Concrete Conduits for Electric Cables.

No. of ducts	2	4	6	12	16
No. of tiers	1	2	2	3	4
Width of conc., ins..	13¼	13¼	18	22¾	22¾
Depth of conc., ins..	8½	13¼	13¼	18	22¾
Concrete area, sq. ins.	91.74	133.80	175.86	284.22	350.52
Conduit area, sq. ins.	20.88	41.76	62.64	125.28	167.04
Concrete per ft. of duct, cu. ft.....	0.32	0.23	0.20	0.16	0.15

Notes on the Water-Supply of Havana, Cuba.

By R. WINTHROP PRATT.*

The first water-supply of the city of Havana was derived before the year 1600 from the Almendares River, at a point four miles southwest of the city. Here was built a diverting dam 15 ft. high of rock construction, and the river water was diverted through an open aqueduct, known as the Zanja Real, which on reaching the city was divided into several smaller open channels through which the water passed the various portions of the city and then into the harbor.

This water-supply became too badly polluted with the growth of the city to permit of its use for drinking. Therefore, in 1835 there was installed a 20-in. cast-iron pipe line leading to the city; and a filtration system was established a short distance above the original dam. A limited distribution was at this time also installed and the works called the Aqueduct of Fernando VII.*

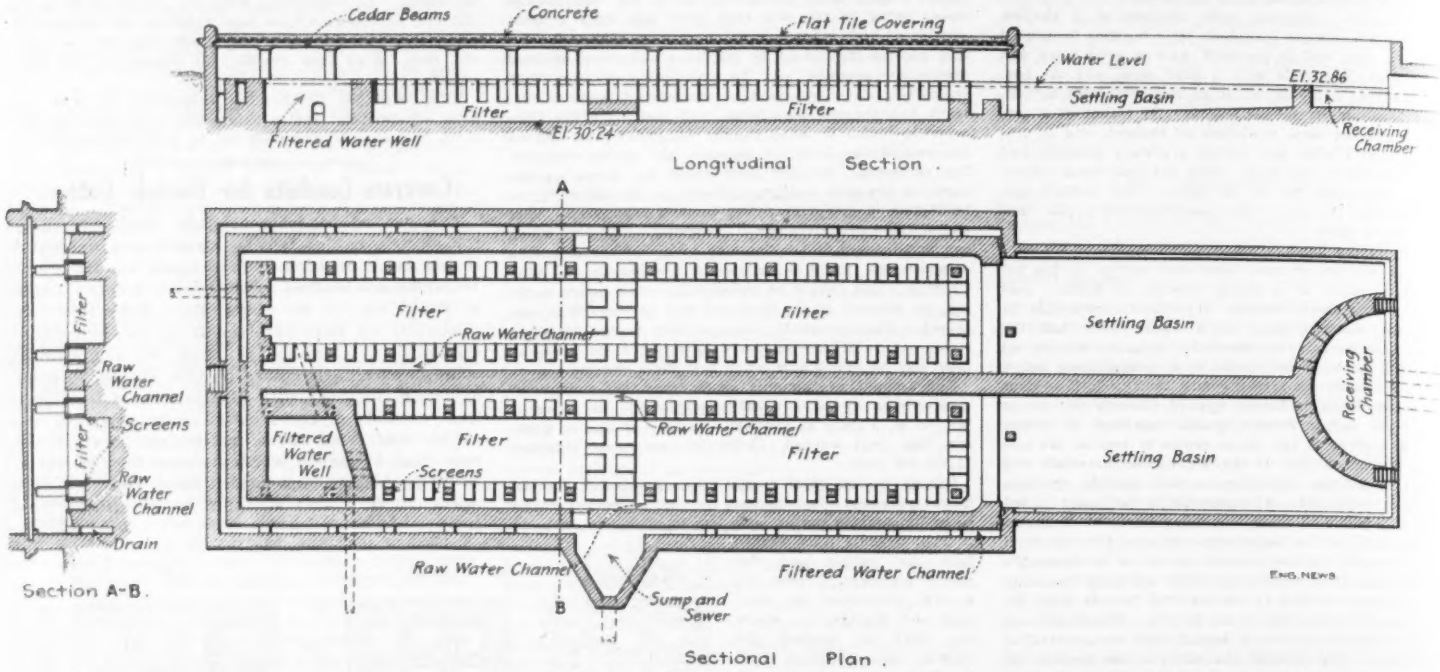


FIG. 1. PLAN AND SECTIONS OF THE FILTERS OF FERNANDO VII., FORMING A PART OF THE OLD WATER-SUPPLY OF HAVANA, CUBA.

Antique Filter Plant.

The filter plant is of interest as being, probably, the oldest artificial one in the world, built along the general lines of certain modern plants; or to be more exact, built along the lines of some of our preliminary filter plants or "scrubbers." The general design will be understood from the plan and sections, Fig. 1, supplemented by the views, Fig. 2. The construction is of brick, plastered with cement, and the walls are all unusually heavy as compared to modern design.

The water, diverted from the Almendares River, which is near by, passes by gravity into one or both of the settling basins, each holding about 80,000 gals., from which it overflows into channels which pass around each filter unit, above the level of the filtering material. At intervals of every 2 ft. in the dividing wall between this channel and the filters, are rectangular openings, 2 ft. wide, in each of which are inserted two wire screens having a mesh of about ⅛-in. A very large screening area is thus provided, through which the water passes before being applied to the filters.

Each filter unit is approximately 61 × 13 ft. in plan, with cement floor, and contains about 4 ft. of filtering material, consisting of "piedra china" or gravel composed of small hard black stones ranging from ¼-in to 1 in. in diameter. No sand is used; neither are there underdrains; but the filtered water passes directly from one end of each filter into the filtered water well, and thence by gravity to the city. Opportunity is provided for wasting the water by means of a drain, passing around the filters, at a lower elevation.

The filters, channels and clear wells are all covered by a flat roof, supported by piers at an elevation of 10 or 12 ft. above the filters. This roof is constructed of cedar beams and planks, covered with a lime mortar, composed of lime, sand and stone in equal portions, on top of which are roofing tile. That the roof should have remained serviceable for 75 years is worthy of note.

As the filter has not been used since the municipal water-supply has been available, it impossible to discuss the efficiency of operation more than to say that it is believed that the plant served to reduce greatly the large quantity of suspended matter which existed in the raw river water at times of heavy rains. The of operation must have been great, as the screens needed frequent attention and it was often necessary to remove and clean the filtering material.

Present Supply.

The present water-supply system for Havana was constructed by Spanish engineers between 1859 and 1894, being completed, it will be noted, before the Spanish-American War.

The water is derived from springs which issue from the base of abrupt hills of porous limestone formation and which border the Almendares River at Vento, five miles above the original water-works, and some nine miles from the center of the city of Havana. The large capacity of the springs (more than 30,000,000 gals. per day during the dryest periods) suggests the existence of an underground river flowing from a southerly direction through the limestone rock. More water can readily be obtained by proper development in the same district. With a total population of but 300,000, and an inadequate distribution system, the above-mentioned quantity will be sufficient for some time.

In developing the present supply, the water-bearing rock was stripped and opened for a distance of some 200 ft. back from the Almendares River and slightly above the average level of that stream. A horseshoe-shaped area, about

Fig. 2. Exterior View of Old Water Filters, Havana, Cuba.

(Built in 1835. The screens are to shut out possible intruders. The settling reservoirs show in the foreground.)

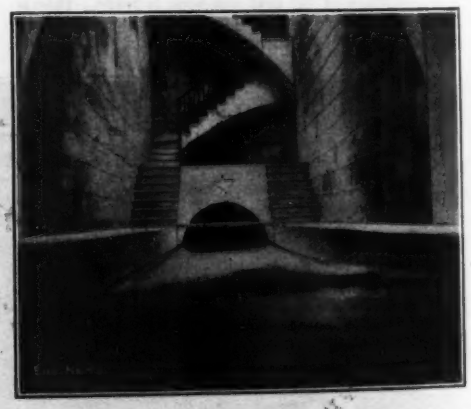


Fig. 3. View of Interior of Vento Aqueduct Tunnel at Lower Shaft, Havana Water-Supply.

*Chief Engineer Ohio State Board of Health, Columbus, Ohio; late Director of Sanitary Engineering, Republic of Cuba.

*Aqueduct or in Spanish "Acueducto" is used in the same sense as the English term "water-works."

60 x 60 ft., was then enclosed by masonry walls resting on the rock and extending, on a 1 to 1 slope, through a vertical height of about 25 ft., thus forming a basin or "taza." (See view, Fig. 3.)

This construction, together with storm-water drains, prevents the entrance into the spring of surface wash from the surrounding hills. It does not prevent the river water, during its high stages, from passing backward through the porous rock and affecting the quality of the spring water; and the problem of protecting the water-supply from this influence of the river is one which the present government authorities are trying to solve.

From the receiving basin the water overflows at a depth of 4 ft. and passes over a weir into the aqueduct which conveys the water by gravity to the distributing reservoir at Palatino. This aqueduct is of brick masonry, of oval form, the horizontal and vertical axes being 6.6 and 9.7 ft. respectively. It is six miles long and for most of its length is located just below the surface of the ground. Flowing less than half full, it is sufficient for the present needs of the city (which consumes about 30,000,000 gals. per day), but the flow cannot be greatly increased without causing leakage through the upper part of the aqueduct.

Just after leaving the springs the aqueduct is replaced by an inverted siphon 250 ft. long, extending under the Almendares River. This siphon consists of two 30-in. cast-iron pipe lines, located in a masonry tunnel, approximately 8 ft. in diameter. The construction of this tunnel and the two wide shafts leading down to it, at both ends, is an unusually fine piece of cut-stone masonry work; although it would be considered by most American engineers as unnecessarily expensive for the purpose it serves. Furthermore, the tunnel is not deep enough to be beyond danger from freshets in the river. This tunnel, as well as the spring itself, constitute one of the principal points of interest for sight-seers, and during the tourist season there are many visitors to Vento.

Quality of the Water.

The water from the Vento supply is very clear and sparkling; and as it issues, in the tropical sunlight, from the limestone rock into the basin of light-colored cut-stone masonry, it looks very attractive. As would be expected, however, the exposure of this ground water to the sunlight causes a luxuriant growth of algae; and this necessitates the constant employment of two men to scrape the green growth from the bottom and sides of the basin. These men are obliged to stand all day in water up to their waists, in ordinary clothes; but the efforts of the writer have resulted in the purchase of heavy rubber suits—an improvement, at least, from an ethical if not from a hygienic standpoint. It has been proposed to use copper sulphate as a means of preventing the growths of algae; but the storage available is probably not sufficient to permit the successful use of this chemical.

The water contains a large amount of lime, principally in the form of carbonate, and for this reason is somewhat objectionable for certain domestic purposes as well as for boiler uses.

The following memoranda have been translated from the official report of the National Health Department Laboratory of the analysis of a sample of water collected from Vento on March 21, 1910.

PHYSICAL AND CHEMICAL.
(Parts per Million.)

Turbidity	None
Color	None
Odor	None
Free ammonia	None
Albuminoid ammonia	None
Nitrates	0.5
Nitrites	None
Residue on evaporation at 110	328
Loss on ignition	28
Organic material (principally lime)	248

BACTERIA.

Total, 4,333 per cc.; B. Coli.....None in 10 cc.

Distributing Reservoir.

The brick aqueduct terminates at the Palatino reservoirs, located on high ground at the outskirts of Havana. From here most of the city is supplied by gravity, although the pressure afforded, by reason of the comparatively slight elevation of the reservoir and also by reason of the poor distribution system, is not great. To supply several of the more recently developed and higher portions of the city, pumping is necessary; and for this purpose several pumps of moderate capacity have been installed at Palatino in the past.

The reservoirs consist of two sections, each 200 ft. sq. and 15 ft. deep. The aqueduct enters at one end of the dividing wall while at the other is located an elaborately-designed gate-house of the Spanish type of architecture, in which are located the valves controlling the flow of water to the various parts of the city.

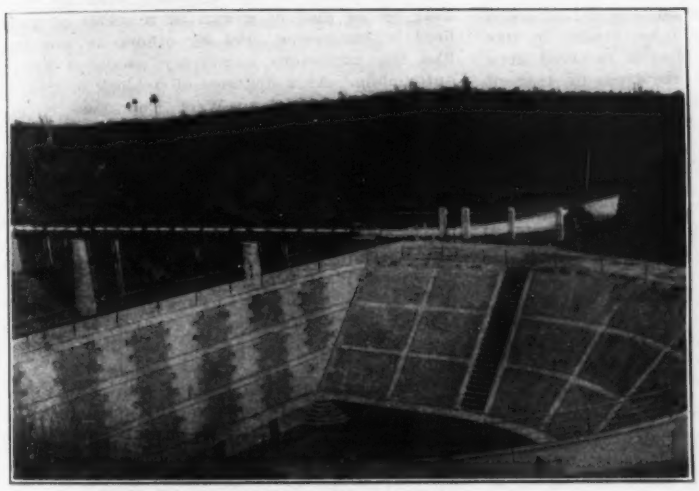


FIG. 4. GENERAL VIEW OF RECEIVING RESERVOIR, VENTO SPRINGS, HAVANA WATER-SUPPLY.

FIG. 5. EXTERIOR VIEW OF VENTO TUNNEL, HAVANA WATER-SUPPLY, AS IT PASSES FROM SHAFT TO AND UNDER RIVER.

Gas Explosions in an Electric Conduit, New York City.

By A. A. BRENEMAN,* M. Am. Chem. Soc.

In Engineering News of Dec. 2, 1909, the writer described a gas explosion in the sewers of a section of New York City, between 42d and 53d Sts., on the West Side. It was pointed out there that gasoline and other combustible volatile liquids from automobile garages were the sources of trouble.

Another explosion has recently occurred under a considerable length of certain streets of New York, but as the trouble arose from entirely different sources and as all such sub-surface explosions are of interest to municipal engineers this latest case has seemed worthy of discussion.

On the evening of April 9, at 10.30 p. m., there was an explosion in the manhole of the electric conduit of the Empire City Subway Co. at 70th St. and West End Ave.; almost at the same time there was a rapid succession of explosions along the line of the same conduit. The testimony of people who were upon the street or in adjacent houses at the time of the explosion was, as usual in such cases, quite conflicting and the facts are given here as representing what seems to be a preponderance of testimony in regard to the different points involved. The explosion at 70th St. was followed by one in the corresponding manhole at 73d St., and this latter in quick succession by similar explosions in the manholes along West End Av. at the corners of 73d to 77th Sts., inclusive. All of the explosions, except that at 77th St., which was very light, had about the same degree of intensity, judging by the mechanical effects: such as displacement of the manhole covers, by the tearing up of the asphalted street, and by the interval between explosions which was no more than two or three seconds.

The manhole covers consisted of iron frames, circular, with a large flange below and a heavy round lid bolted upon the mouth of the frame. The frame and lid together weighed 1,800 lbs. At the flange, where the frame had its extreme width, the diameter was about 5 ft. and that of the lid, including its overlap, was about 3 ft. This cover is supplemented by an inner cover or pan which is bolted down upon the frame to exclude water. Such a manhole, therefore, is, ordinarily, a tightly closed space with no ventilation except what is possible through the pores of a brick wall, or from its connection by the pipe duct with other manholes, a block away in either direction. Provisions for ventilation were made in many manholes, as shown later. The manhole is a brick-walled pit, square, with rounded corners in its lower part and with its wall drawn in to a circle at the top upon which the flange of the frame rests. Over this flange and over all the adjacent parts of the street is a 6-in. layer of concrete resting upon a bed of sand with earth beneath it and having on top of the concrete a layer of asphalt 2½ to 3 ins. in thickness. The ducts of the conduit which carry the electric wires are 3-in. wrought-iron pipes laid symmetrically in two horizontal rows, four pipes below and two above, in a continuous block of concrete of about 2 ft. by 1 ft. in cross-section and running from one manhole to another. The concrete is laid in a trough of wooden planks. The ducts are cut off at the wall of each manhole, leaving a clear working space in the pit. Into these ducts are put the wire cables (insulated wires bunched together and sealed in a lead sheath) which run through the ducts from one manhole to another and are then bent around along the side of the manhole and run into the ducts along the other side. The ducts just noted are devoted entirely to telephone and telegraph wires and carry therefore, ordinarily, only low-tension currents.

Through each manhole runs an iron pipe about

*Consulting and Analytical Chemist, 97 Water St., New York City. Late expert Member Municipal Explosives Commission; formerly Professor of Industrial Chemistry, Cornell University.

4 ins. in diameter, resting against the wall of the manhole a few inches above the line of the ducts and somewhat low down on the opposite side of the manhole runs a 6-in. cast-iron water pipe of the city supply. The upper pipe has openings into each manhole and is connected with a blower so that it can be used for ventilation of the manholes. Reference to Engineering News, April 6, 1893, p. 319, discloses the history of this ventilating pipe. Several manhole explosions, in the period from 1887 to 1889, when the conduits were comparatively new, so alarmed the citizens that the very existence of the conduit systems was threatened. As it was then stated:

> The citizens would not long endure the existence of an explosive magazine under them, transforming the manhole cover at each corner into a death-dealing projectile.

The cause was believed to be due to the inleakage of illuminating gas from leaky gas mains. Mr. W. J. Baldwin, M. Am. Soc. M. E., was commissioned to study the problem of preventing these explosions and he advised a forced ventilation system of which the pipe above noted was a part.

A 6-in. wrought-iron pipe was run along the conduit line, passing through each manhole. This pipe distributed air from 12 blower stations. The air escaped from small holes into the manholes and produced therein a slight plenum preventing the inleakage of gas. The size of the holes increased with the distance from a blower station. Where steam was readily available, steam-driven Root blowers were used; in other locations the drive was by gas engine. About 1 HP. was needed per mile of conduit line.

There were many manhole explosions before the introduction of this system, especially in the regions below 23d St. and between Third and Ninth Avs. The manholes at that time were smaller and the frames and covers also were smaller than those used at present. Iron pipes for the ducts also have been largely replaced in new construction by perforated blocks or tile of vitrified stone ware. These early accidents generally resulted in projection of the iron covers into the air sometimes to great heights and they were a serious menace to street traffic. They have been much less frequent of late years and none of them, as far as the writer knows, have shown such serious tearing up of the street surface as the ones which are described in this paper. The ventilating pipe in the 70th St. manhole has not been used for some time, as explosions have not occurred in this part of the conduit system and as ventilation has been held to be unnecessary.

Immediately adjoining the low tension conduit, but separate from it, was a similar conduit carrying lighting circuits and using, of course, current at much higher tension. There was nothing to show, however, that there was any metallic contact between the two systems and the writer is informed by those who have tested the circuits that there was no indication of higher potential in either of the large pipes above mentioned that ran through the manholes. The origin of a spark, therefore, is difficult to account for upon any general view; yet it is beyond question that the explosions which occurred were originated in some way by an electric spark. The system of manholes and conduits was a closed system with tops effectually sealed and with tight brick walls otherwise enclosing the manhole, and there was no opening through which flame or any lighted combustible substance could have been introduced.

The surface of the street was only about 14 ins. above the top of the brick wall on which rested the frame of the manhole cover. Any pressure from within the manhole, if of sufficient magnitude, must be relieved by displacing the manhole frame and cover, or by tearing up the street around it, and rupturing the wall of the pit. The effects of the explosion on April 9 at 70th St. were to tear up the surface of the street for a depth of from 15 ins. to 2 ft. for a space of from 10 to 12 ft. square, and to throw out the 1,800-lb. cover which fell back after the explosion into the hole. It would seem from an inspection of these openings that the pressure was first exerted upward upon the manhole cover, and that this, as it rose, ripped up the layer of concrete and asphalt in fragments of considerable size, which fell partly outside but mainly back into the excavation. There is nothing to show that the covers of any manholes flew to any great height, although there are exaggerated stories of witnesses who saw them in the air at the height of a 3-story house. The fact that the covers fell back into the excavations shows that they could not have gone very high. Considering the wide base of this cover and the manner in which it was held down by earth and concrete and asphalt, it is unlikely that it would rise in a vertical line, and if it rose at any other angle to the street surface it could not have failed to fall outside of the excavation if it had gone to any great height, as the holes were only from 10 to 12 ft. square. Moreover, there was no dent in the asphalt pavement outside of the excavations such as would have been made by these heavy masses of iron falling upon it from any height. They may have gone to a height of 5 or 6 ft. in extreme cases. When it is considered that the force acting upon the cover could move it only a slight distance before that force was released by the opening in the broken pavement surrouding it, it is evident that the flying lid was not actuated by a continuous propelling force behind it, like a projectile in a gun, but that it received little more pressure than that required to tear it loose from its base before that pressure was relieved through other openings.

The writer showed in his previous article on the New York City sewer explosions (Eng. News, Dec. 2, 1909), that the conditions of the city streets were such as to make the escape of illuminating gas into the sewers unlikely. The sewers are 13 ft. below the surface while the gas pipes are only 2½ to 3 ft. Gas pipes and electric conduits are on about the same level, and after the 1889 troubles, Mr. Baldwin found traces of illuminating gas in the conduit systems.

There is always more or less leakage from the street pipes carrying illuminating gas. These pipes form a long and complicated system, having many joints and leakage is inevitable. The presence of gas in the soil under the street is made evident in many cases where the street is torn up and on asphalted streets any gas escaping into the soil is more or less imprisoned by the impervious street surface. The predominant gas in New York City used for illumination is carburetted water gas, especially rich in hydrogen and containing also considerable marsh gas or methane. These two gases are both combustible and, from their lightness, are both highly diffusible, that is, they pass more rapidly through small openings or through a porous substance than other gases. Assuming that the soil in the vicinity of one of these manholes was permeated with gas, its most direct outlet would be through the porous wall of the manhole, and it would tend to form a mixture of gas and air in the closed chamber under the manhole cover. If this aggregation of gas in the soil were merely local, it would escape mainly into the nearest manhole, and from this the gas might permeate through the pipes or ducts, some of which are unoccupied, and open into adjacent manholes. The wooden sheathing of the concrete blocks in which the iron-pipe ducts are laid, is already considerably decayed in places and this decay reduces the size of the wooden box and may leave air spaces between it and the surrounding soil through which gas would find its way, even from points quite a distance from the manhole, into these openings. The manholes for this system occur only at the street crossings. There is one on every block at the southwest corner of the street with its center about 4 ft. from the curved edge of the corner paving stone. Considering the number of explosions and their occurrence in rapid succession, it is probable that the accumulation of gas and air forming an explosive mixture h[ad] occurred through general escape from the soil [of] the street into the manholes along the entire [line] through the course of seven blocks (about 1,[800] ft.) rather than that it had passed through [the] whole succession of ducts and manholes fr[om] one center of leakage.

Mixtures of illuminating gas and air will e[x]plode with a proportion of gas corresponding [to] 4 or 5% of gas and through all intermedi[ate] mixtures up to perhaps 30% or more. Above [or] below these proportions, through slight var[ia]tions, flame can be communicated by a flas[h] but the rate of burning is not sufficiently rapid t[o] constitute an explosion. A mixture containing [a] very little gas or too much gas will not explod[e] and except under certain conditions, will no[t] ignite.

The force exerted by a gas explosion under the conditions above given is considerable, as will be evident to anyone who has examined the openings made in the street, but as has been said, the construction was not such as to allow the most destructive utilization of the force. The shallow covering of the street about the manhole gave a ready relief to the force and the result was rather that of a vigorous push upon the manhole cover and the street surface for an instant before the pressure was released through the opening made. The sound of the explosion was not great; it was described even by those near by as that of a gun or a series of guns, fired in succession, and by others as sounding like the explosions commonly produced by an automobile. At a distance of a block or two, in the streets parallel to West End Ave., it was scarcely noticed, and, if heard at all, was described as a dull, smothered sound, like that of a distant rock blast. There was no projection of fragments of the pavement to any distance; there was no concussion to speak of and no windows were broken, although there were windows in some cases within 20 to 25 ft. of the manhole. West End Ave. is a quiet street, entirely given up to residences, and at 10.30 in the evening there were few persons or vehicles on the street. There was no record of anyone being injured in any way, as might have happened from flying fragments or the upheaval of the street. It is satisfactory to know that the menace from such explosions as this is not really so serious as might be apprehended.

It is worth while to consider, so far as data can be brought to bear upon the question, what may have been the actual force exerted in this case. The average composition of illuminating gas (water gas) as used in New York City, may be expressed by the following figures, in per cent by volume:

Hydrogen	29.5
Carbonic Oxide	29.0
Marsh gas (CH_4)	18.0
Heavy hydrocarbons (principally Ethylene, C_2H_4, or Olefiant gas)	12.0
Nitrogen	8.0
Carbon di-oxide	3.0
Oxygen	0.5

The heavy hydrocarbons above include many different gases and vapors, some of which are of higher calorific power than Ethylene, (Propane, Butane, Benzol vapor, Acetylene, etc.) but they are all calculated here as Ethylene which is the preponderating factor because no substantial error is involved and because the computation would be otherwise too complex.

This gas has a value of 155,286 calories per cubic foot, and a flame temperature, when burned with the exact quantity of air required for complete combustion, of 2,900° C. The capacity of the manholes was estimated, roughly, at 100 cu. ft., and the pressure, at the instant of explosion, upon the lid of the manhole, was about 56 tons as a maximum; it may have been much less. This pressure, of course, acted instantly upon the under side of the street pavement over a surface of 10 to 12 ft. square, confined and held together by the somewhat tough and plastic coating of the overlying asphalt. Great as the force may seem at first, it was barely sufficient, when so diffused, to rip up the street over this area and there was no energy left for a scattering or projection of the fragments. The testimony of

witnesses is, uniformly, that there was no appearance of flame or smoke, nor any abundant cloud of dust or small fragments and the appearance of street and sidewalks confirmed this testimony.

The fact that there were no explosions between 70th and 73d Sts., while every successive manhole from 73d to 77th St. was broken open, is somewhat puzzling. Evidently, flame was transmitted through the manholes of 71st and 72d Sts., and the intervening portions of the conduit, but there was no explosion. It can only be assumed that in the case of these two manholes, there was a gas mixture too poor or too rich in gas, as explained above, to produce an explosion, but still sufficient to transmit a slight flash or flame, through the ducts to the successive manholes following, until the true explosive mixtures were reached at 73d St. and beyond. The local conditions responsible for these exceptions, can only be surmised.

Considering broadly the whole question of conduit explosions, it is evident that the number of explosions is limited by the infrequency of the conditions of ignition, at least in conduits of the low-tension type. The opportunities for gas leakage are abundant and yet the explosions are relatively few. However, serious injuries may result from such explosions as have been described, and it is worth while to take every precaution to prevent them. It is doubtful if much more can be expected at present in the prevention of gas leakage. The loss from this source is very considerable to the gas companies, and they would naturally tend, in time, to adopt such precautions as were possible, but it is nevertheless worth while, from the point of view of city government, to insist upon such precautions as will insure safety in this direction. The replacement of cast-iron pipes with calked joints by wrought-iron ones with screw connections, is continually going on and will greatly reduce gas leakage in the future.

As to the part played by the electric cables; those carrying high-tension currents are most to be feared, other things being equal, because of their facilities for ignition. It will require a longer study of the subject to say what are the relative dangers of the two classes of conduits as the accidental escape of current from one to the other seems still to be possible. In general, manhole volumes should be as small as practicable, so that the quantity of gas or explosive mixture shall not be great in the aggregate. A brick wall is hardly tight enough to fulfil requirements under existing conditions. Such a wall could be made much less porous by a uniform surface of cement plaster, covered with a coat of tar such as is used in foundations. As these pits are tightly closed by the covers, such a precaution is all the more important. With larger manholes and with the great increase of lighting and power currents that have come in in recent years, it is evident that the danger, even for the low-tension conduit-system (which runs parallel and close to those carrying high-tension currents) having separate manholes is an increasing one. There were two electric conduit explosions in New York in 1909, and several of the same class in other cities. It is evident that these explosions are still to be expected with more or less frequency. There are manholes or chambers under the New York streets in connection with the electric-conduit system, which are much larger than those described above, and the result of a similar explosion in one of these would be a much more serious matter. Considering the conditions of a crowded city street, in which such heavy projectiles as manhole plates or frames may be hurled through the air, or where the solid pavement may be suddenly and violently heaved up over a wide area, the danger is one to be averted quickly and at any cost.

The essential precaution is the establishing of a good and continuous system of ventilation. If ventilation is not general at present, it should be made so. In the case here described, the ventilation pipes were in place, but had been out of use for some time, as ventilation was not considered necessary. There are doubtless many other parts of the city, in which similar accidents are possible. It is not enough to depend upon insulation alone to prevent the consequences of an electric spark, which seems in all underground explosions in our street to be the most common source of ignition. Gas leakage is always going on and there are, probably under present conditions, hundreds of cases in which an explosive mixture of gases exists to one opportunity of its ignition by a spark or otherwise. When these opportunities coincide, however, the explosion and its consequences are serious enough to warrant any means of prevention that are available. With an effective system of ventilation of the manholes by air forced through them, with proper means of escape of the ventilating currents from the manhole, it is probable that good inspection, including chemical testing of the manhole gases at intervals, would render impossible such explosions as have been described. It is entirely likely that conditions could be so controlled that continuous ventilation would be required in very few localities, while the *possibilities* would be known for every section of the city, and no risks would be taken. The present conditions represent merely a happy-go-lucky indifference under a continual menace of street explosions and no one is in a position to tell, from any systematic or accurate study of this subject, where or when or how such accidents are most likely to occur.

Annual Meeting of the American Society for Testing Materials.

[*Concluded from p. 26 of the issue of July 7.*]

Iron and Steel.

CAST-IRON TEST BARS.—As noted in the report of Committee A-3, on Cast-Iron, there are to be a number of tests undertaken to determine the proper length of test bars in cast iron. In a paper entitled "Tests on Arbitration Test Bars," Mr. C. D. Matthews gave the results of some of the above tests which he had completed. He experimented on round pieces 1¼ ins. in diameter and cast separately in lengths of 26 ins. on end in dry sand molds and then tested in transverse rupture across spans of 12, 18 and 24 ins., respectively. The results seem to indicate a 12-in. bar is too stiff, and a 24-in. bar too weak for satisfactory and uniform results. The first conclusions therefore were that the length of span best suited for testing the 1¼-in. bar is somewhere between 12 and 24 ins. Subsequent tests on bars of this length showed that between 14 and 20 ins. the results are quite uniform, and any length between those values should be satisfactory. The discussion brought out that a length of 16 or 18 ins. will probably be adopted as the international arbitration test bar specification.

In this same connection properly should be placed a paper by Mr. A. E. Outerbridge, Jr., Chemist and Metallurgist, Philadelphia, Pa., entitled "Some Recent Tests of Cast-Iron." These tests were made on two test bars varying ¼-in. in lateral dimensions from each of six different ladles. These test bars were then pulled apart and broken across 12-in. spans to determine, if possible, the effect of different times and conditions of cooling upon bars of slightly different sizes poured from the same ladle. It was noted that (1) the tensile strength of different bars of the same dimensions was uniform when cast from the same ladle; (2) the smaller test bars (¾-in. square) showed higher strength than the larger bars (1 in. square) cast from the same ladle. In the opinion of the author this shows the necessity for a rigid standard in the size of cast-iron test bars.

CLOSING BLOW HOLES IN STEEL INGOTS.—In a report on this subject made to the society at last year's meeting. Prof. Henry M. Howe stated as his opinion that by proper rolling it is possible to remove all blow holes which may be found in ingot steel. He based this conclusion on certain specific-gravity experiments and microscopical examination of polished sections that he had made on rolled steel that had contained a number of blow holes in the ingot. At the meeting this year, Prof. Howe presented further evidence to support his contention of last year. He had cut from a steel ingot billets which were rolled into a plate and from that plate were taken small thin sections. These slices were then bent over double through a 180° angle, and, although there were blow holes in the original ingot, in no case, even under a microscope, did these show up cracks in the bent edge of the thin plate of a pipe comparable with the original blow holes, thus demonstrating that welding must have occurred. Prof. Howe renewed his statement of last year that though ordinary rolling might not bring about this welding, it was possible with due care to do so.

LOW-CARBON STREAKS IN OPEN-HEARTH RAILS.—Mr. M. H. Wickhorst (C., B. & Q. Ry., Aurora, Ill.,) in a paper of the above title described some open-hearth rails which failed by splitting through the head in various directions, through the web vertically or diagonally, vertically from the head to the base and in other ways. On slicing sections from a few of these rails and etching the face with picric acid solution in alcohol, it was found that most of the split rails showed light streaks or patches, indicating streaks of metal low in carbon. As the smaller streaks usually contained a nucleus of slag it was at first thought that slag in the metal was the cause of the streaks, but it was afterwards learned that the large streaks, at least, were caused by a practice at the mill of putting soft Bessemer steel plates on the stool of mold to reduce the cutting out of the stools by the hot metal. These plates melt partly and become partially mixed with the poured metal, but not thoroughly, so that the streaks are left in the ingot. When this result was discovered the practice was stopped.

TITANIUM IN BESSEMER RAIL STEEL.—Mr. G. B. Waterhouse (Buffalo, N. Y.,) in a paper entitled "The Influence of Titanium on Segregation in Bessemer Rail Steel," gave some tests to show that titanium, like aluminum, when rightly applied in the proper amount, is found to retard segregation of sulphur, phosphorus, and carbon, in what is normally quiet, quick-setting steel. The tests were made first on ingots from an ordinary rail-steel heat and from a heat to which had been added 64 lbs. of ferro-titanium, which amounted to only 0.25% of the weight of the heat. Each steel was analyzed in the ladle and then poured, borings taken every 3¼ ins. up and down the ingot and these borings also analyzed. It was found that in the ordinary steel in the ladle the sulphur content was 0.098%, while in the ingot there was a maximum of 0.223%, with a considerable area more than 0.147. In the titanium steel the sulphur content in the ladle was 0.068, and that in the ingot a maximum of 0.101%. Phosphorus in the ordinary steel rose from 0.088% in the ladle to a maximum of 0.167 in the ingot, while in the titanium steel the corresponding figures are 0.093 and 0.124. Carbon in the ordinary steel varies from 0.44% in the ladle to 0.69% in the ingot as compared to 0.47% and 0.67% for the titanium steel. In all cases the segregated areas in the treated steel were much smaller than in the ordinary steel. Similar results were found in long rails.

In criticism of the test Mr. Henry Souther (Hartford, Conn.,) said that the time the heat was held in the ladles before pouring (3 mins.) was too long, as it will allow the ingot to chill and assist segregation.

TEST OF STEEL PLATE PARTLY FUSED BY ELECTRIC CURRENT.—Some years ago a short circuit took place in an electric conduit resting on one of the plate girders of the Park Ave. viaduct of the New York Central & Hudson River R. R., in New York City, and before current could be shut off had fused the conduit pipe and burned the underlying girder cover-plate quite extensively over its surface and in one place at least clear through the ¾-in. thickness. The plate was removed and tests were made upon it to determine the effect of the fusion on the structure. These tests were re-

ported to the Society by Mr. A. W. Carpenter (N. Y. C. & H. R. R. R., New York). The tests included a full-size tension test of the plate, tension test of small piece cut from the unaffected portions of the plate and a microscopical examination. The results of the tests and examination are stated as follows:

Microscopic studies of parts of the plate cut from fused and from unaffected portions revealed the following conditions: The parts unaffected by the fusing showed a fine structure without distinct granulations and with the excess of ferrite common to low carbon bridge steel. The structure of the fused portions was changed and enlarged, from which it was concluded that the material would be rendered brittle (borne out by the subsequent tensile tests). The welding of the copper and steel from the conductor and conduit with the steel of the plate, was complete and did not show distinct inclosures of any oxides between the surfaces. The general structure of the plate showed a number of original inclosures of oxides such as are commonly found in all plates. It was considered that the original material should be classed as excellent.

The conclusion drawn from the tests was that the character of the metal was changed by the electric burning, but that the injury did not extend far beyond the limits of the visible burning. This local change in the character of the metal was enough, however, to reduce the static strength of the plate tested as a whole some 40% and to destroy its ductility; from which it was further concluded:

(1) That a plate with a similar injury would be unreliable for service, and

(2) That if the local injury were cut away the balance of the section could be depended upon to develop practically the same unit strength as prior to the injury.

COPPER-CLAD STEEL.—Mr. Wirt Tassin (Duplex Metals Co., Chester, Pa.) in a paper entitled "Copper-Clad Steel; Its Metallurgy, Properties and Uses," described the process devised by his company for welding a skin coat of copper on an interior core of steel, to be used mainly as a non-corrosive current-carrying wire, but also for light structural shapes where non-corrodability is a desirable asset. This process was described in Engineering News, Nov. 14, 1907, p. 521.

CUPRO-NICKEL-STEEL.—Mr. G. H. Clamer (Philadelphia, Pa.), in a paper entitled "Cupro-Nickel-Steel" described the investigations that have been made upon the alloy of copper, nickel and iron. Copper alloys of iron have been known for some time, but their properties have not been such as to recommend them very much for commercial use, although the presence of a small amount of copper has admittedly been in a good many irons for a good many years without damaging the product; in fact, it is thought that it is of benefit in some cases. Mr. Clamer noted the surprising results obtained by the joint addition of copper and nickel. He said that alloys can be produced carrying from 5 to 20% copper, which without nickel would be extremely hard, brittle and red short, but these become by the addition of nickel in the proportion of 20 to 50%, highly ductile, easily forgeable and easily machinable. He gave a test of a typical alloy having 19½% copper, 45% nickel, and 0.2% carbon which had an ultimate strength of 98,230 lbs., an elastic limit of 54,150 lbs., an elongation of 35% and a reduction of area of 47.9%. Alloys at the lower range of the series can be bent cold at 180° without fracture, and are highly resistive of corrosion. The metal can be produced from Monel metal, which furnishes a very cheap base for its manufacture.

Oils and Bitumens.

THE DETERMINATION OF SOLUBLE BITUMEN.—The paper upon this subject was presented by Mr. Prevost Hubbard (U. S. Bureau of Public Roads) and Mr. C. S. Reeve (Assistant Inspector of Asphalt and Cement, District of Columbia). It discussed the various reagents commonly used for determining soluble bitumen, and the methods for applying the same. As typical bitumens, coal, tar-pitch, water gas, tar pitch, residual oil, blown oil, Bermudez asphaltic cement and Bermudez asphalt were chosen. A series of soluble tests were given in duplicate on these products, having as a solvent chemically pure carbon bisulphide and 90% Benzol. The object of the tests was to determine that reagent and that method of procedure which would give most uniform results using the cheapest possible reagent and in such manner as to consume the smallest amount of time and labor. The results showed that the "Extractor" method (which was described in detail) gave higher solubility results but less concordant results than the other methods described, namely, cold extraction with 17 hr. settling time, cold extraction with 15 min. settling time, and hot extraction with 3 hrs. settling time. These three latter methods gave results which the authors considered practically identical and they, therefore, recommend that the 15 min. cold extraction method be used. The reason assigned for unsatisfactory results with the "Extractor" method was that the finely divided insoluble portions of the bitumen were carried through the extractor. They also discussed the problem of insoluble compounds of the solvent and the soluble portions. As to the relative merits of the carbon bisulphide and the 90% Benzol the authors conclude that the former is the more satisfactory.

This paper was discussed by Messrs. S. R. Church, A. W. Dow, W. H. Fulweiler and Albert Sommer. In the discussion it developed that chemically pure benzol could now be obtained as cheap as carbon bisulphide, and the use of this reagent was advocated as being equally as good as carbon bisulphide from a chemical standpoint and rather less dangerous to use. Very satisfactory results could be obtained by the use of two solvents in succession rather than by one alone.

REFORMS IN PETROLEUM PRODUCTS' SPECIFICATION.—Mr. Albert Sommer (Consulting Chemist, N. Y.,) read a paper entitled "The Necessary Reforms in Specification for Petroleum Products." He maintained that there has arisen a necessity for sweeping changes in the specification for various petroleum products. He says that the old idea that the specific gravity, flash color and viscosity tests are sufficient does not prove true with the new oils, other than Pennsylvania, which are now on the market, and also in view of the new uses to which oils are being put. Among the various changes which he suggested the most fundamental were the introduction of the distillation test for gasoline and burning oils, and of a tar test devised by Kissling. He showed by actual results that he has obtained in his laboratory that the gravity of naphthas and burning oils means nothing to the user and the distillation tests for these products ought to be substituted therefor. He also showed that the Kissling tar test should be applied to oils that are to be used for automobile cylinder lubrication, steam turbine lubrication, and lubrication of superheated steam cylinders. In the discussion it was asked if the present tests advocated by Mr. Sommer would distinguish between ordinary illuminating oil and the special long-time 120-hr. oils required by railways in signal work. Mr. Sommer replied that the modification of the Kissling tar test and distillation test would be sufficient to distinguish between these oils.

PITCH TESTING MACHINE.—A new machine for testing pitch was described by Mr. T. Y. Olsen, Philadelphia. This machine was built by Mr. Olsen's firm under the direction of Mr. W. H. Fulweiler (United Gas Improvement Co., Philadelphia). It consists of a weighted pendulum which hits a crank lever forcing apart two dies glued together with a standardly applied pitch. It is intended not to measure viscosity or adhesion, but rather the impact binding strength, such as is experienced in a road whose products are bound together with a bitumen. The machine is not entirely completed as yet, nor is it in a satisfactory condition, but it is thought that it will be of considerable value when it has been perfected.

A TESTING MACHINE FOR BITUMINOUS MATERIALS.—Mr. H. Abraham (Standard Paint Co., Bound Brook, N. J.,) described in some detail an instrument he had invented for ascertaining the tenacity and ductility of bituminous materials. The test is made by pulling apart small molded specimens of bitumen and measuring on an autographic instrument the tenacity and ductility. The material is subjected to a tensile stress applied to a cylinder of exactly 1 sq. cm. cross-section and 1 cm. in length, so as to cause it to be drawn apart at the uniform speed of five centimeters per minute. The maximum reading in kilograms is equal to the "tenacity." The elongation in centimeters at the moment the material parts in the preceding test is a measure of its "ductility."

Preservative Coatings.

EXPOSURE TESTS OF STRUCTURAL STEEL COATINGS.—Although submitted to the Secretary too late to be placed on the printed program, a paper by Mr. C. M. Chapman (Westinghouse, Church, Kerr & Co., New York), entitled "Some Exposure Tests of Structural Steel Coatings" was presented to the Society. The tests shown in this paper seem to contradict to some measure previous experience in similar tests, and on that account and also because a number of the members did not hear the announcement of the proposed reading of the paper, so that no discussion was available, it was thought best not to reproduce the paper here. Suffice it to say that it describes a series of tests made by Westinghouse, Church, Kerr & Co. upon a number of small steel plates, each coated with a so-called steel preservative paint. These plates were coated with preparations submitted by 271 manufacturers or dealers and placed on a roof of a building on Manhattan Island and there allowed to remain, some of them for two years and some for one year. At regular intervals each plate was examined and a record made of its condition, according to an arbitrary scale of ratings based upon the amount of apparent rust. In a table presented by Mr. Chapman the various kinds of coatings, according to information from the manufacturer, are classified and the average rating of each class given. In the one-year-exposure tests the white leads and the red leads seem to show the highest rating, that is the least amount of rusting, and the mineral hydro-carbons the lowest. In the two-year-exposure tests the red leads were again the best, while the white leads drop off considerably. Contrary to other experiments, the chromates were found to be very low in rust preventatives.

Testing Machines.

A 600,000-LB. HYDRAULIC TESTING MACHINE.—Messrs. H. F. Moore and M. O. Withey (University of Wisconsin, Madison, Wis.), described a new 600,000-lb. hydraulic testing machine which has been recently installed in the University of Wisconsin. This machine is notable particularly because it was built largely by the staff of the University, without outside aid, and also because of its low cost—something under $4,000. It is so arranged that it can be used in transverse bending, compression and tension tests, by changing the connections at the upper and lower heads. One interesting feature is the heavy weighing table which is made up of a reinforced-concrete beam and slab.

AN ELUTRIATING DEVICE.—Mr. G. W. Thompson (National Lead Co., New York) described in some detail an elutriating device which he has perfected for the classification, according to size, of fine particles, such as make up paint pigment or cement. This consists of a series of superimposed brass cones, through the bottom of each one of which a slow-moving heavy liquid, such as oil, is forced, and into the top one of which the powder to be classified is placed at the beginning of the operation. The slow-moving oil carries the fine particles over the edge of each successive cone in proportion to the size of the particle and the speed of the liquid which is controlled by the size of the cone; thus five classifications—one for each cone and one at the end of the series—can be made.

Mr. Thompson also read a paper on "A Solubility Test on Protective Coatings," which described a test that he had made by painting several small planks with various coverings and daily subjecting them to water spray. The object of the paper was not to show the difference between the various coatings which he used, but to illustrate the method of making the test.

THE SCLEROSCOPE.—Mr. A. F. Shore read a paper upon the scleroscope, a machine invented by himself for the testing of the hardness of metals. This machine consists essentially of a small diamond-tipped hammer falling, in a glass tube, upon the metal to be tested, the degree of hardness being measured by the height of the

rebound of the hammer as read upon a gage on the tube. Apparently this would give a reading for elasticity, but the size of the diamond point is so small the falling weight gives a pressure of above 200,000 lbs. per sq. in., quite sufficient to exceed the elastic limit of any metal, so that elasticity does not enter as a factor.

OTHER TESTING MACHINES.—Prof. J. Madison Porter (Lafayette College, Easton, Pa.) described, with the aid of some of his apparatus, which had been brought to Atlantic City, a number of different devices used in the testing laboratory at Lafayette College. These included a cement shaker sieve, cast-iron molds for concrete tension cylinders, and micrometer attachments for reading fiber deformation of beams.

Mr. H. C. Berry (University of Pennsylvania, Philadelphia, Pa.) described, with the aid of some large drawings, the device used in the University of Pennsylvania laboratories to impart repeated loads on concrete cylinders in compression.

Mr. T. Y. Olsen (Philadelphia, Pa.) described an autographic rubber testing machine which is now being made by his company.

Cement and Concrete.

ALUMINATES IN LIME AND CEMENT MORTAR.—In Engineering News, Dec. 10, 1908, p. 658, there were given the results of a number of tests made by Mr. Henry S. Spackman (Philadelphia, Pa.) upon the beneficial effect of calcium aluminate added to lime and cement mortars. At this meeting of the Society Mr. Spackman presented a paper entitled "Aluminates; Their Properties and Possibilities in Cement Manufacture," which reported the results of a great number of further tests upon this same subject. Within the past two years Mr. Spackman's laboratory has tested some 30,000 briquettes treated in some manner with alumina compounds. The present paper gives the deductions made by the author from these tests and some tables showing representative results of the various combinations of compounds.

The process consists in adding to lime and natural cement mortar various proportions of calcium aluminate as a dry mix, and then testing the neat and mortar briquettes so formed in the regular tension tests. In the tables submitted by Mr. Spackman it was shown that in various mixtures of aluminates with lime, trass, clay, ashes, slag (all finely divided silicious material) the tension tests, both neat and in mortar, show much higher than in ordinary lime mortars. When mixed with ordinary natural cement, various percentages of calcium aluminate raise the tensile value of briquettes 200 to 600%, in many cases above the standard requirements for Portland cement. The exact reason for this increase in strength and the best proportion of mixture have not been determined, but in the light of these experiments, the author considers that for many purposes it will be possible to substitute a lime-alumina or a treated natural cement mortar for one of Portland cement at a great saving in cost.

SODIUM SILICATE AS A SURFACE HARDENER FOR CONCRETE.—Mr. Albert Moyer (Vulcanite Portland Cement Co., New York) read a paper in which he described the use of sodium silicate, applied in the form of water glass, to an already hardened concrete, as a surface hardener. He reported that experiments have shown that sodium silicate, thinned with water, and applied to the surface of concrete, seems to enter the pores of the concrete and to form a so-called "mineral glue" closing up those pores and forming a water-tight, dustless surface.

Dr. A. S. Cushman (Washington, D. C.), in the discussion, stated that the action of sodium silicate on concrete was in line with the colloidal theory of the setting of cement. Concrete in setting requires a certain amount of water; if it gets too little or too much it will not be as strong as when it gets just the right amount. If a setting briquette of concrete be placed in kerosene after it has reached its initial set, it will finally reach a higher strength than if it were allowed to set either in air or in water because in the kerosene it can neither give nor take water and, having just the right quantity of water to reach its initial set, continues its setting under ideal conditions. Somewhat the same condition exists when sodium silicate is applied to the surface of a setting concrete; it takes up part of the water from the concrete so that if there is too much for perfect setting the process is benefited. However, herein lies just the trouble in using sodium silicate to determine the correct quantity to add and the result is that very often too much or too little water is taken up by the silicate and the concrete loses rather than gains strength.

Several members bore out Dr. Cushman's statement by saying that experiments with sodium silicate have often reduced the strength of concrete and have not always made it waterproof or dense.

LIME MORTAR TESTS.—Mr. E. W. Lazell (Wilmington, Del.), reported upon a long-continued series of tests upon the strength in tension and compression upon briquettes made of lime mortar, of sand and hydrated lime, lump lime and cement lime, respectively. The results are all in tabular and diagrammatic form that cannot be abstracted here but the following conclusions are of value:

(1) All lime mortars, whether they contain Portland cement or not, are stronger when prepared from hydrated lime than when prepared from quick lime. This might have been predicated, because the product of lime hydration by mechanical means in a plant properly equipped for the purpose is better than the product obtained by hydrating lime in the customary way of slacking with a hose and a hoe. In the common method of slacking, the paste or mortar must be aged for a considerable time to insure the complete hydration of all the quicklime particles.

An advantage of the use of hydrated lime in place of lime paste in the preparation of mixed mortars lies in the greater ease of incorporation of the dry hydrated material with the other ingredients.

(2) The dolomitic limes are shown to have been stronger at the end of one year than the high calcium limes. It is often stated that limes made from dolomite are unsuited for use in mortars containing Portland cement, because of their high magnesium content. The results from these experiments show no deleterious action from the magnesia, but on the contrary, indicate that the magnesia is a valuable ingredient, contributing to the strength of the mortar. It is well known that mortars made from dolomitic limes show no signs of disintegration even after years of exposure to the elements.

REINFORCED-CONCRETE BEAM TESTS.—Mr. A. T. Goldbeck (Lafayette College, Easton, Pa.) described in some detail the method and results of a series of tests on reinforced-concrete beams in flexure, in which the extension and deformation of the fibers of the beam are measured by a special apparatus. In connection with these same tests, tension tests were made on 84 16-in. cylinders, extremely large pieces for this type of work.

REINFORCED-CONCRETE COLUMN TESTS.—Mr. M. O. Withey (Univ. of Wisconsin, Madison, Wis.) continued his report of last year on concrete columns, this year presenting the results from the tests of 12 columns, longitudinally as spirally reinforced, under eccentric and repeated loads. He concludes that ordinarily, under central applied loads, the best reinforcement for a concrete column is cement, but that under eccentric loads, longitudinal rods are extremely desirable to take bending stresses so induced. Except that there is practically no increase in set or deformation after a few repetitions of loads equal to 40 to 50% of the yield points of the columns tested, the author makes no deductions as to repetitive loading. It was observed that there was a considerable additional strength and toughness afforded by the spiral after the yield point of the longitudinal steel was passed, and that the formula

$$\left(S = \frac{P}{A} \pm \frac{M_c}{I}\right)$$

commonly used in designing short homogeneous columns eccentrically loaded may be applied to reinforced-concrete columns providing suitable allowance for the steel.

SAND SPECIFICATION.—A paper entitled "A Sand Specification and its Specific Application" was read by Mr. W. A. Aiken (Philadelphia, Pa.). This consisted of a tabular exhibition of the value, shown by a quantity of experiments, of a specification for sand advocated in a paper read before the Society two years ago by Messrs. Lesley and Spackman. Mr. Aiken said, in answer to a question, that the question of a high silica content in sand (95%, according to the specification) was of more importance than any other, even than that of grading. A high-silica poorly-graded sand would, as a rule, show better results than a low-silica well-graded sand.

PAINTING CONCRETE SURFACES.—Mr. Charles MacNichol described a method that he had used successfully in preparing concrete surfaces so that they will take ordinary paint. This consists merely in washing the surface with a solution of zinc sulphate, which combines with the time of the concrete to form zinc oxide and calcium sulphate, instead of the alkali that in ordinary concrete surfaces reacts with the oil of the paint to disintegrate the latter. Several members testified to the success with which this method had been used.

The following papers were read by title only: "Measured Strains in a Steam Boiler under Hydrostatic Tests," by Mr. James E. Howard; "Further Notes on the Heat Treatment of Steel," by Mr. Wm. Campbell; "Brinell Ball Test Applied to Wood," by Prof. W. K. Hatt; "The Exponential Laws of Endurance Tests," by Prof. O. H. Basquin; "Vermilion Paint for Railway Signals," by Mr. Robert Job.

Other papers presented were "Unevenly Chilled and Untrue Car Wheels," Thomas D West (Sharpsville, Pa.); "Elongation and Ductility Tests on Rail Sections Under the Manufacturers' Standard Drop Testing Machine," P. H. Dudley (Sault Ste. Marie, Michigan); "A Comparison of Magnetic Permeameters," Charles W. Burrows (U. S. Bureau of Standards, Washington, D. C.), and "Apparatus for the Microscopical Examination of Metals," Albert Sauveur, Harvard University, Cambridge, Mass.

THE CITY OF MELZINGA, N. Y., to consist of the present villages of Matteawan and Fishkill Landing, was provided for by a bill which passed both branches of the New York Legislature but was vetoed by Gov. Hughes because of important technical defects which would seemingly have thrown doubt upon the validity of the proposed charter. Had the charter gone into effect, Melzinga would have been the first city in New York State operating under the so-called commission plan of city government. The bill provided for a council of only three members, to be known as Commissioners of Public Affairs and Safety, Finance, and Public Works, each to be elected at-large for a term of four years. The Commissioner of Public Affairs and Safety would have been ex-officio mayor, but without veto power. He would have been head of the Police and Fire Department, ex-officio president of the Board of Education, and ex-officio auditor. The Commissioner of Finance would have served as city treasurer, city collector, city clerk, and city assessor. The Commissioner of Public Works would have been street commissioner, water and sewer commissioner, health and sanitary commissioner, inspector of weights and measures, besides having the supervision of parks, parking and shade trees of the city and superintending "the architectural beauty of the city" and making "recommendations as to suitable color, style and character of buildings, paving, sidewalks and other improvements as to him may seem advisable, to the end of improving the city's appearance and beauty." Each of the three commissioners would have been expected to give all of his time to "city affairs during business hours." The salaries named in the bill were $500 a year for the commissioner serving as mayor, and $1,500 a year for the other two. Evidently there was some mistake in the act as to the salary of the mayor, or else it was expected that the added dignity attaching to his office would be worth $1,000 a year. The act provided for nominations by petition, preferential voting at elections, the recall, initiative and the referendum. For the exercise of the initiative, 50% of the voters were required on petitions calling for special election on the proposed ordinances, and from 25 to 50% for ordinances to be submitted at a general election. To secure a referendum vote on ordinances passed by the Council, a petition signed by 25% of the voters was demanded by the bill. An election would have been unnecessary in the case of either the initiative or referendum petitions, provided the council rescinded or passed the ordinances involved, respectively. It would appear that the only offices to be filled by appointment by the council were those of city attorney, health officer, and five members of the Board of Education, the latter to serve with the mayor as a board of six. The bill contained very detailed provisions as to general taxation, assessments for benefits and other phases of local administration.

Native Iron Smelting in Upper Guinea, West Africa.*

By J. MORROW CAMPBELL,† Assoc. Inst. Min. & Met.

In various parts of the Gold Coast Colony, from the shores of the Nani Lagoon to Ashanti, are to be seen heaps of slag, although no remains of furnaces could be found. These slag heaps considerably puzzled the writer, and no satisfactory explanation of their origin could be obtained. They are generally attributed to the Portuguese, but this is not credible. They are always found in the vicinity of ferruginous rocks which might be used as iron ore, and they present every appearance of having been the result of iron smelting.

Early in 1908, en route to Upper Guinea, the writer traveled overland from Conakry to Kouroussa, on the head waters of the Niger River, and thence down the river. About 14 miles from Kouroussa, immediately on the right bank of the river, is a small village called Babela. Here were found three native iron furnaces, two of which were in operation and one cold, the iron having been removed and lying outside. Measurements of the furnaces were taken and some information obtained as to the modus operandi, as they seemed different, in at least one respect, from any native process so far recorded. The writer proceeded to Siguiri and spent 18 months prospecting on and near the divide between the Niger and the Senegal basins. Slag heaps and abandoned furnaces are to be found in hundreds, dotted over the country in all sorts of positions, some beside villages, and others in remote parts of the bush; but during the whole period, never again was a furnace seen in operation, and inquiry of many Europeans there did not result in finding any one who had ever seen one actually at work.

Having happened to see these furnaces when en route, the writer not unnaturally supposed them to be representative of an industry common in the country; consequently, neither photographs nor adequate samples were taken. Natives say that this system of iron smelting is practised not only by the Bambaras, but by other tribes, south of the Sahara.

It seems somewhat remarkable that there should be practised, in Guinea, a method of iron smelting of which no record appears to exist, and which differs radically from any other native method. The primitive iron furnaces used in Burma and the East Indies seem to be the only ones recorded as being operated without artificial blast of any kind. These, however, are invariably provided with a stack of some height which induces a draft.

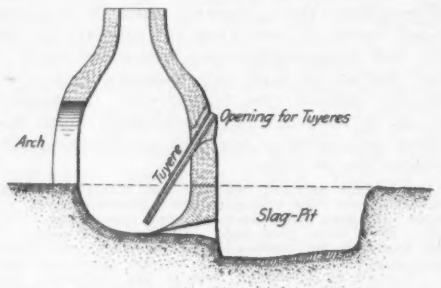
Description of Furnace.

The Babela furnaces are circular in section, about 5 ft. in external and 3 ft. 6 ins. in internal diameter at the base. For 18 ins. above ground the walls are practically vertical inside and out; above this the diameter contracts rapidly up to about 4 ft., where the curvature gradually diminishes until the walls are vertical, when the top is reached at a height of slightly more than 5 ft. The internal diameter is then about 1 ft.

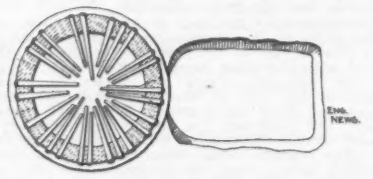
CONSTRUCTION.—The furnace is built as follows: From a point on the ground, two concentric circles are traced, about 5 ft. and 3 ft. 6 ins. in diameter respectively. The earth is scooped out of the inner circle to form a hollow hearth about 18 ins. deep in the center; from this point and on the same level, a narrow trench is cut radially, connecting with a hole of indefinite area and over 2 ft. deep, dug in the ground outside the outer circle. This trench is for the purpose of drawing off the slag, and the hole is for its reception. The walls of the furnace are then commenced; they are built of stiff, wet, yellow clay, well puddled. Opposite the trench a semi-circular archway, about 2 ft. wide and about 2 ft. 6 ins. high, is left. The walls are from 9 ins. to 1 ft. thick at the bottom, diminishing to about 6 ins. or less at the top. When the walls have reached a height of 18 ins., about a dozen irregular elliptical holes about 1 ft. long by over 6 ins. high are left at equal intervals. A number of open pipes or tuyeres, tapering from about 2 ins. at one end to over 1 in. in internal diameter at the other, and over ⅛-in. in thickness, are made of a mixture of clay and sand and thoroughly dried in the sun. These are inserted, small end downward, at an angle of over 45°, sometimes one, but usually two or three, into each one of the series of elliptical holes. One Babela furnace had 24 and the other 26 tuyeres. They are not of quite uniform length, and reach to from 9 ins. to 3 ins. of the hearth. Their upper ends are luted around with stiff clay, which keeps them in place and entirely closes the elliptical holes.

OPERATION.—Combustible matter is next placed on the hearth, and upon this charcoal. The archway before mentioned is then built up with stones and clay and luted tight, the slag aperture blocked, and the furnace is filled to the top with a mixture of iron ore, broken to less than 1½-in. cubes, and charcoal. The charge is lit by the introduction of live charcoal through the tuyeres. Air, of course, passes down the tuyeres, and the products of combustion escape from the top of the furnace. Slag is drawn off from time to time as may be necessary. In 6 to 8 hours the charge has run down, when the furnace is again filled to the top with a mixture of ore and charcoal, and the process repeated thus during the total run, which occupies about 30 hours. No flux of any kind is used, but the lower ends of the tuyers are gradually eaten away. At the end of the run all slag is drawn off, the archway built up at the commencement is broken down and the mass of reduced iron, amounting to from 200 to 300 lbs. in weight, is dragged out of the aperture and cooled with water. It is a spongy mass of steely iron, including considerable quantities of slag and charcoal. It is broken up with some difficulty, as it is tough, and subsequently worked up in small quantities by ordinary blacksmith's methods.

The iron reaches a pasty condition in the furnace and is never really molten. The furnace serves for several runs but obviously cannot last long. New tuyeres are inserted at the commencement of each run.



Section through Arch (Door) and Slag-Opening.



Sectional Plan showing Arrangement of Tuyeres.

Native Iron Furnace, Upper Guinea, West Africa.

The ore used is of lateritic origin. The composition of one piece taken is given in the following analysis, for which I have to thank Mr. George T. Holloway, of Chancery Lane.

	%	Equivalent to.
Loss on ignition, including combined water, carbonic acid and organic matter	18.00	
Iron Oxide (Fe_2O_3)	57.29	Iron 40.11%
Alumina (Al_2O_3)	20.48	
Manganous Oxide (MnO)	1.34	Manganese 1.04%
Lime (CaO)	0.21	
Magnesia (MgO)	0.12	
Silica (SiO_2)	2.08	
Sulphuric Acid	0.01	Sulphur 0.005%
Phosphoric Acid	0.35	Phosphorus 0.15%
Loss and unestimated constituents	0.12	
	100.00	

This ore would not seem to be self-fluxing. Only a small sample was taken, and it possibly may not have been a fair specimen of the ore used. There is, however, a large quantity of free silica in the tuyeres, the lower ends of which are slagged away during the run, and these may help to provide the flux that is evidently necessary. The natives add no flux of any kind. It is regretted that a sample of the slag was not taken.

It seems extraordinary that in a furnace under 6 ft. high, such as has been described, a sufficiently high temperature for the smelting of iron should be obtained without artificial blast, but, on consideration, it is not so surprising, as the air supply, before it reaches the point where its oxygen enters into combination, is at a high temperature owing to its having passed through red-hot tuyeres; in short, we have a crude but effective form of hot blast. This explains the usefulness of a method which at first glance would seem to be quite impracticable.

In the second of two volumes just publishen in Italian, giving the scientific results of the Duke d'Abruzzi's expedition in Central Africa, there is found a description of the native method of smelting iron from laterite and charcoal in furnaces on the Catalan principle, as practised by natives in Uganda and parts of the Congo Free State. We have, therefore, two totally different native systems of iron smelting which have been observed. It seems probable that the slags found on the Gold Coast and in Ashanti have been produced in furnaces such as are now used in Upper Guinea because in the former it is rarely that there occur the natural physical conditions necessary for the Catalan forge; moreover, the slag-heaps are invariably found near the ore, and not usually beside water.

Native Mine Shafts.

Another item of evidence, which indicates the existence of industrial communication between the Gold Coast and the Guinea gold fields, is that in both places there is found the same type of native miners' shaft, a type never used in recent times. The ordinary mine shaft is, of course, circular, and slightly over 2 ft. in diameter. Ascent or descent is effected by means of two series of foot-holes cut in the sides opposite one another. This is the present system in both places.

In both colonies, however, numbers of ancient shafts are to be seen in which the foot-holes are entirely absent and their place taken by a succession of annular steps. These have probably been made by gradually increasing the diameter of the shaft as it goes down for under a foot in depth, then returning to the original diameter by leaving an annular flat step 2 to 3 ins. wide, again gradually increasing the diameter for an equal depth, leaving another flat annular step, and so on down the entire depth of the shaft. Many such shafts, certainly several hundreds of years old, sunk in laterite, exhibit wonderful regularity in construction.

Whether made as above suggested, or picked back in a shaft sunk with a uniform diameter, this work indicates a high degree of skill on the part of the miners. To make such shafts in hard laterite involved the use of iron or steel tools, and it is probable that the requirements of the miners as well as those of the fighting men, with their iron-tipped arrows and spears, were supplied by native smelters. A long time must have elapsed, however, since the natives smelted iron near the African coast, European iron being so cheap and easily obtainable. The industry lives only in the more inaccessible parts of the continent.

*A paper presented before the British Institution of Mining and Metallurgy in London, April 21, 1910.

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Power Economy from Coasting Tests on the Manhattan Elevated Railway, New York.*

By H. ST. CLAIR PUTNAM,† M. Am. Inst. E. E.

Object of Clock Tests.

The power required for the operation of electric railways can be predetermined with great accuracy providing the cars or trains are operated in the manner assumed in the calculation of the speed-time and power curves employed for this purpose. Unfortunately, the cars are seldom operated as they should be, and though allowance for this variation is made, engineers have long recognized that a material saving in power could be realized in electric railway operation if the motormen could be induced or trained to operate the trains in a manner approximating the speed-time curve used in the preliminary calculations. It is proposed in this paper to describe some tests made on the Manhattan Elevated Division of the Interborough Rapid Transit Co., New York, in which a clock was used to record the amount of coasting employed in the operation of trains, the object of this device being to obtain from the motormen a better manipulation of the trains with the resulting economy in the use of power.

The clock as used in the tests consists of a clock mechanism manufactured for factory and office use for recording the time of employes. To the balance wheel escapement a braking device has been added, as shown in Fig. 1, which is lifted free from the balance wheel by an electromagnet which is energized only during the coasting of the train. This permits the clock to record the coasting time only. Each motorman is provided with an individual key which he inserts on taking charge of the train and again on leaving. The turning of this key records the motorman's number or initials and the time as shown by the clock mechanism; the difference in the time between the two records made by the key representing the total time of coasting during his run. The slip record is torn off by the motorman and turned in to the proper official. This is checked up with his running time, and the motorman is rated according to the percentage that the coasting time is of the total time of his run, due allowance being made for variation from the schedule. His individual rating is based upon the average results of a week or month as may be selected.

The electric circuits controlling the clock are interlocked with the master controller and the brake mechanism and arranged so that the coasting clock will start only after the two actions of turning the power on and then off.

Speed-Time Curve Characteristics.

While the principles involved in the use of speed-time curve calculations in electric operation are well understood, for the purpose of making clear the economics in power consumption that can be realized from

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the better operation of trains, which it is the object of this clock to encourage, the following brief discussion of the various factors entering into electric operation is given.

ACCELERATION.—The rapid acceleration of trains, providing the schedule speed is unchanged, results in an important saving of power for two reasons. First, the maximum speed reached is less with a high acceleration, and consequently the train resistance is somewhat less; second, and of much greater importance, is the fact that with a high rate of acceleration, the speed at the start of breaking is less than with a lower rate and, consequently, the energy absorbed and lost in braking is less. The energy absorbed in braking is the essence of the whole subject, as in such train operation as that on the Manhattan system, and to a lesser extent in single car operation the increased train resistance resulting from the higher maximum speed due to a slow acceleration is unimportant and may be neglected. The only energy not utilized in useful work is that absorbed in the rheostats in direct-current acceleration, the motor and control losses and the energy absorbed in the brake shoes. The equipment provided naturally limits the permissible rate of acceleration, but within such limitations, a quick acceleration is one of the most feasible methods of saving power in such service as exists on the Manhattan Railway.

In the tests on the entire Manhattan system conducted on March 22, 1910, the acceleration of different motormen was found to vary from 0.9 to 1.47 mi. per hr. per sec. Providing other factors of train operation remain the same (that is, the braking, running time and time of stop) the increase in the rate of acceleration from 0.9 to 1.47 mi. per hr. per sec. will result in an increase in the percentage of coasting time from 0 to 40.5% of the total time, and a saving of up to 36% in energy consumption. A motorman on the Manhattan system on full runs will average about 600 car miles per day, and the power used at the car with 0.9 acceleration will approximate 2.82 KW.-hr. per car mile. As between these two motormen, therefore, providing the scheduled speed is maintained, the motorman who accelerated his train at an average rate of 0.9 mi. per hr. per sec. will waste during the day 610 KW-hr. at the car. With 80% efficiency to the power-house, this becomes 762 KW.-hr. This power of course must be supplied from the power-house where additional apparatus must be installed to meet the demand. In practice the full saving of power resulting from better acceleration is not realized, owing usually to the better running time made by the good operator. This results frequently in his having to wait for the train ahead and by so doing, a large part of the saving in power which should follow his good operation is lost. The use of this clock should result, however, in a material increase in coasting time under such circumstances, with a resulting saving in power. The men will learn to gage their trains, and instead of stopping for the man ahead, will utilize the surplus time in coasting. In order that schedules shall be maintained, however, some sort of penalty must be imposed to prevent the motorman from over-doing the coasting at the expense of the running time.

SERIES RUNNING.—An increase in the percentage of coasting obtained by reducing the amount of series running does not effect a corresponding saving in power. This is due to the fact that while the total time during which power is applied is increased and the time of coasting reduced by holding the controller in the full series position, say for four or five seconds, the actual power used remains practically the same because the additional power required on account of the longer time of power application is offset in large measure, if not entirely, by the saving in rheostat losses owing to the reduced time that the rheostat is in circuit in passing to full multiple. A limited amount of series running, therefore, is not objectionable, and under certain conditions it is better to run in series for a short time than to pass to the multiple position, especially where power is cut off almost immediately after the multiple position is reached as under certain conditions in approaching a station. The decrease in coasting time resulting from a moderate amount of series running does not therefore necessarily represent an increase in power consumption, unless the series running has been excessive. In this respect the coasting clock will give misleading results; but as under normal conditions there is little occasion for running in series, excepting around curves, the error thus introduced into the record is not important.

BRAKING.—A high rate of braking results in a reduction in power consumption for reasons similar to those existing as to the rate of acceleration. It permits the power to be cut off at an earlier point, a longer time of coasting introduced, power otherwise wasted in the brakes to be recovered and the train brought to a quick stop. Perfection in braking is much more difficult of attainment than in acceleration, as the train must be stopped at the station within a space limited to a few feet. The motorman, therefore, in approaching a station must judge his distance, speed, grades, if any, as well as the weight of his train, and over-running the station causes serious delay. Many motormen therefore, operate on the side of safety and feel their way into stations, with a resulting material increase in the power used if schedules are maintained.

A rate of 2 mi. per hr. per sec. is entirely practical as has been determined by carefully conducted tests. An increase in the rate of braking between the limits of 1 mi. per hr. per sec. and 2 mi. results in increasing the coasting to 48.5% of the total time with a saving in power of 35.5%.

In the tests made over the Manhattan system on March 22 the trains were not equipped for getting the braking rate. The average time required by the motorman in bringing the train to a stop varied from 10.2 to 20.2 seconds. This would indicate approximate braking rates of 1.15 and 1.90 mi. per hr. per sec. The higher rate would increase the coasting time from 26% for the lower rate, to 47.5%, and result in the saving of approximately 280 KW.-hr. per day by the better operator.

STATION STOPS.—On the Second Ave. line, the average run between stops is 0.335 mile and the maximum possible stop with the maintenance of the schedule, and with no coasting, is 16.2 seconds, assuming an average run as typical, which is substantially correct for the purposes of the present discussion. A reduction in the time of stop to 10 seconds results in an increase in coasting time to 45% of the total time and a reduction of 40% in the power used.

COASTING.—The amount of coasting which a motorman can obtain and still maintain his schedule, is obviously the result of the factors of operation above discussed. The ideal amount of coasting will result from the observance of all these factors. The theoretical coasting as shown on the typical curve is 27.5% of the total time including stops. It has been shown in the above discussion that it is possible to obtain this amount of coasting and even to exceed it by changes in operation which are entirely within the range of practicability.

It makes but little difference which factor is altered. The percentage of power saved is substantially the same however the increased coasting is obtained. This of course is to be expected. It is well to point out the very large saving in power consumption which results in reducing the stop from say 15 to 10 seconds, assuming that the schedule speed remains the same. This results in the saving of 25% in power through the increased coasting thus made possible.

Test Results.

SECOND AVE.—All trains on the Second Ave. line were equipped with coasting clocks, and the power supplied to the section between 127th St. and Canal St., was metered by direct-current integrating wattmeters on the substation feeders before and after clock installation. Corrections have been made for heaters and light, and the wattmeter readings corrected in accordance with frequent calibrations.

On account of the corrections that have to be made for heaters, light, control and auxiliaries, the results obtained are necessarily approximate. Under these circumstances, therefore, the records are remarkably consistent and show graphically the material improvement in coasting which has resulted from the use of the coasting clock, and also the reduction in the power required for the operation of the cars.

Quantitatively, the power per car mile obtained from the tests is about 7% higher than the calculations. The test results are measured at the substation while the calculations are at the car. The difference would represent the third-rail losses, but it is believed that they are somewhat greater than this would indicate. The important feature is that on the Second Ave. line the increase in the time of coasting from 10% as it was prior to the installation of the clocks to 38% following such installation, resulted in a saving of 25% in the power required for traction. This result is in agreement with what should be expected from the theoretical calculations.

TRAIN TESTS.—In order to compare the operating conditions existing on Second Ave. line with the conditions on the other lines of the Manhattan system, on March 22 a test train was run in actual service over all divisions of the Manhattan system. A seven-car train composed of four motor and three trail cars was used. Each trail car was equipped with one of the recording clocks. One clock was used to record the coasting time, the second the time of power application, and the third the time of braking. Stop watch records were also made of the time of series running and total power application, time of coasting, time of braking and time of station and signal stops.

The result of these tests are shown in the tables at the bottom of the page.

Second Ave.—It will be noted that motorman S in test No. 2 obtained 50.5% coasting, the largest amount recorded during the day. Of the three tests on Second Ave., Motorman O in test No. 5, obtained the smallest amount of coasting, 41.4% and carried power for the longest time, 31.6%, yet he was the better operator. If he had used the same time in making the run as motorman S in test No. 2, it would have been possible for him to obtain as high as 58.5% coasting as shown by the broken line on test No. 5, and he could have cut his power application down to 22.2% with a saving of 8% in power as compared with motorman S in test No. 2. The good results in test No. 5 were obtained with an acceleration of 1.47 and braking of 1.85 (approximate) as compared with an acceleration of 1.35 and braking of 1.75 (approximate) in test No. 2.

The motormen who operated the trains on the Second Ave. line were selected men and the runs were made to illustrate what could be accomplished after a thorough training of several months. The average coasting obtained in the three runs is 45.2%. This indicates a saving in power consumption amounting to 34% as compared with the conditions existing on this line prior to the installation of the clocks. This, of course, is in excess of the average saving of all the men as these men were specially selected. These tests also bring out strongly that any system of rewards or ranking of the men based upon coasting time should include a penalty for overrunning the scheduled time.

The tests on the Second Ave. line, as observed, show an average of 45.2% coasting which corresponds to 170 KW.-hr. per car-mile at the car.

RECORDING CLOCK TESTS—MARCH 22, 1910. MANHATTAN DIVISION, INTERBOROUGH RAPID TRANSIT COMPANY.

Second Ave., 129th St. to South Ferry.	Power applied. min.	Coasting, min.	Braking, min.	Stops, min.	Total time by watch, min.
Test No. 1—Stop watches	11.7	18.8	5.3	7.0	42.3
8.01 a. m. S.—Recording clocks	11.9	19.6	6.3	....	....
Test No. 2—Stop watches	11.1	19.8	4.4	3.7	39.1
8.45 a. m. N.—Recording clocks (to 127th St. only)	10.5	20.9	4.9	....	....
Test No. 5—Stop watches	12.0	15.8	5.0	4.8	37.5
1.23 p. m. S.—Recording clocks	11.0	17.0	5.7	....	....
Third Ave., Bronx Park to City Hall.					
Test No. 3—Stop watches	27.1	7.5	11.3	10.4	56.7
9.45 a. m. S—Recording clocks	26.0	6.3	12.5	....	....
Test No. 4—Stop watches	21.1	15.4	9.8	8.9	55.1
10.53 a. m. N.—Recording clocks	19.8	17.8	10.0	....	....
Sixth Ave., 155th St. to South Ferry.					
Test No. 6—Stop watches	19.2	10.7	8.6	8.1	46.8
2.6 p. m. N.—Recording clocks (Start Battery Place)	18.0	11.0	9.0	....	....
Test No. 9—Stop watches	19.9	10.3	10.4	6.6	47.9
4.23 p. m. S.—Recording clocks	18.5	11.5	12.5	....	....
Ninth Ave., 155th St. to South Ferry.					
Test No. 7—Stop watches	19.9	8.1	8.6	6.0	42.9
2.55 p. m. S.—Recording clocks	18.2	8.2	8.7	....	....
Test No. 8—Stop watches	19.4	9.1	9.3	4.5	43.2
3.39 p. m. N.—Recording clocks	17.8	10.0	9.3	....	....

AVERAGE OPERATING CONDITIONS, RECORDING CLOCK TESTS—MARCH 22, 1910. MANHATTAN DIVISION.

Second Ave.	Average length of run, ft.	Average acceleration, seconds.	Average power applied, seconds.	Average coasting, seconds.	Average braking, seconds.	Average stop, seconds., Station.	Average stop, seconds., Signal.	Average total time, seconds.
Test No. 1-S	1,723	11.4	26.0	41.7	11.9	13.2	2.4	95.2
Test No. 2-N	1,752	11.5	25.7	45.6	10.2	8.8	...	90.3
Test No. 5-S	1,723	10.3	26.7	35.0	11.2	9.9	1.3	84.1
Third Ave.								
Test No. 3-S	1,767	14.6	42.7	11.8	17.9	16.8	...	89.2
Test No. 4-N	1,767	12.8	33.2	24.2	15.6	13.2	1.3	87.5
Sixth Ave.								
Test No. 6-N	1,841	14.5	38.5	21.4	17.1	14.3	2.5	93.8
Test No. 9-S	1,833	11.4	38.4	19.9	20.2	11.2	2.0	91.7
Ninth Ave.								
Test No. 7-S	1,833	17.2	41.1	16.7	17.8	11.3	1.6	88.5
Test No. 8-N	1,833	19.1	40.2	18.7	19.3	9.3	0.6	88.1

Third Ave.—In the Third Ave. tests, the run south was made with the motorman whose turn it happened to be. This run shows 13.2% coasting. The run north was made with an experienced man and shows 27.6% coasting. The difference is due mostly to the difference in the rate of acceleration, but partly to the braking rate and partly to an excessive amount of series running in test No. 3.

These two runs show an average of 20.4% braking which indicates 2.22 KW.-hr. per car-mile at the car. These men, therefore, used 30.6% more power than was used by the men on the Second Ave. test.

Sixth Ave.—The motormen were taken as they came, and their handling of the train is in fairly close agreement.

On account of the number of turns on this line, the amount of necessary series running is considerably in excess of that obtaining on the other lines. The average coasting obtained was 22.3%. This corresponds to a power consumption of 2.17 KW.-hr. per car-mile. As compared with the average obtained in the Second Ave. tests, this represents an excess consumption of power of 27.7%.

Ninth Ave.—The motormen were taken as they came, and it will be noted that the two men operated their trains very much alike. In both cases the acceleration was poor and the braking somewhat below the standard. Both used a large amount of series running.

The Ninth Ave. line is an ideal one on which to obtain a large amount of coasting on account of the longer runs, easy schedule and long grades, yet the coasting obtained by these two men was but 18.9% and 21.2%, respectively, and averages 20.1%. As compared to the average obtained in the Second Ave. tests, this represents an excess consumption of power of 31.8%.

Clock Records.—In the tests of March 22, the motormen were conscious of being under observation by the test crew as well as by their own road officials, and under such circumstances they naturally tried to do their best. The results obtained therefore, cannot be regarded as representative of actual conditions, but can be taken as fairly representing the best that these men could do, and therefore, as illustrating the knowledge of the motormen in general. The tests were too few in number, however, and the conditions under which they were made were such that they are not regarded as representative.

In order to determine the fair average conditions as to coasting existing on all divisions of the system, tests were made on the Second and Third Ave. lines last fall and two trains equipped with clocks were put in regular service this spring on the Sixth and Ninth Ave. lines.

On the Second Ave. line prior to the installation of the clock, the coasting averaged 10% of the running time. On the Third and Sixth Ave. lines the results agree very closely with those obtained on the Second Ave. The Ninth Ave. line, as already mentioned, furnishes an ideal one upon which to obtain a large amount of coasting, on account of its undulating grades, longer distance between stations, and easy schedule. In addition to this, the average train on this line is made up of four motor cars and two trailers instead of four motor cars and three trailers, as on the other lines.

From the tests it is judged probable that the average coasting obtained on the Manhattan system approximates 12% of the running time.

RESULT OF USING COASTING CLOCKS.—During five weeks on the Second Ave. line, where the coasting clock has been in service for slightly over three months, the average percentage of coasting is 37.5. The average run on this part of the Second Ave. line, as already pointed out, closely approximates the average run for the entire Manhattan system.

VALUE OF POWER SAVED.—The result of these calculations and tests shows that an increase in the percentage of coasting from 12% to 37.5% as shown above, will effect a saving of 24% in the power required for traction.

COASTING VS. POWER MEASUREMENTS.—The various factors that enter into the operation of the train have been analyzed with a view to determine which is the preferable element to measure. The choice practically narrows down to the measurement of either the power input by wattmeter or time of application by means of a clock arrangement, or the measurement of the time of coasting. It is believed that it has been made clear that whatever good results are obtained from the better operation of the train by the motormen can only result in the saving in power through the increase in the coasting time. Coasting is the recovery of power already used, and hence is the key to the problem. The coasting clock, therefore, gives a direct measure of the power recovered by the motormen and as this recovery can also only be made by cutting off the power application sooner, it is believed that it is the most effective element in train operation to measure. At the same time it concentrates the motorman's attention on that element of operation which is the direct reason for the saving in power which results from changes in the methods employed as to the other factors of operation.

William Henry Brown.

Late CHIEF ENGINEER, PENNSYLVANIA RAILROAD.

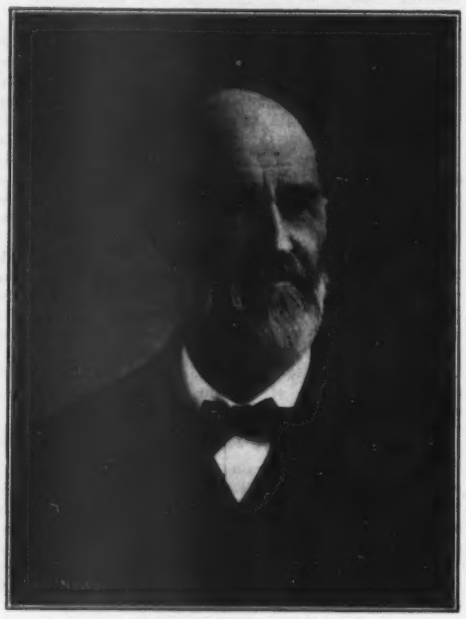
By JOHN C. TRAUTWINE, JR.

William Henry Brown was born, of Quaker parentage, in Little Britain Township, Lancaster County, Pennsylvania, Feb. 29, 1836. He died of heart failure at Belfast, Ireland, June 25, 1910, while visiting Europe with Mrs. Brown.

During his youth, emigration to Kansas was in the air, and young Brown visited an uncle residing in that territory, and met there John Brown, of Ossawatomie.

William H. Brown attended public schools in Philadelphia, graduating from the Central High School. For a time he taught school in Maryland, but soon turned his attention to civil engineering. It is recorded of him that he incurred his father's disapprobation by investing his early savings in an engineer's transit.

He soon entered the service of the third survey district of Philadelphia, under the late D.



William Henry Brown.

Hudson Shedaker; but the outbreak of the civil war called him into more active duty.

As assistant engineer on U. S. military railroads and telegraphs, in 1861, he attracted the attention of the late Colonel Thomas A. Scott, then Assistant Secretary of War (afterward President of the Pennsylvania Railroad Company), who assigned him to duty in Northern Virginia, with headquarters at Alexandria. Here his work was of signal service in connection with the battles of Second Bull Run and Front Royal.

In November, 1862, Mr. Brown became Assistant Engineer on the Pittsburg, Cincinnati, Chicago & St. Louis (Pan Handle) Railroad, then being completed, and in 1863 was made Principal Assistant Engineer. His connection with the Pan Handle road brought him into contact with the Moravians at Gnadenhütten, Ohio; and their unostentatious piety, recalling the sect in which he was born, appealed strongly to him. In after life he often recurred with pleasure to this experience.

On Oct. 1, 1864, he was employed by the Pennsylvania Railroad, in special service on its Philadelphia and Pittsburg divisions.

On Jan. 1, 1865, he became roadmaster of the Pan Handle Railroad; and on March 17, 1865, Engineer of the Oil Creek Railroad.

In July, 1865, began Mr. Brown's forty years of continuous service with the Pennsylvania Railroad, during which he was identified with its development under the administration of five of its presidents. His record, in brief, was as follows:

July, 1865; Philadelphia & Erie Di[vi]sion, Principal Assistant Engineer.

September, 1867; Engineer of Road.

March, 1869; Construction of shops at Altoona, for Maintenance of Way and Car Repairs; Assistant Engineer in charge.

January, 1870; Middle Division; Resident Engineer.

1871; Sunbury & Lewistown R. R., Chief Engineer and Superintendent.

1872; Bedford Division; Superintendent and Engineer.

August 1, 1874; Engineer, Maintenance of Ways.

June 1, 1881; Chief Engineer.

March, 1906; retired at age limit.

During Mr. Brown's term of service as Engineer of Maintenance of Way occurred the Pittsburg strike riots of 1877, and Mr. Brown was active in the restoration of the terminal facilities then destroyed by fire.

As Chief Engineer, in 1881, he completed the Broad Street Terminal in Philadelphia and the elevated railroad connecting it with the former terminal in West Philadelphia; and, in 1893, he had charge of the rebuilding and great enlargement of the new terminal.

In 1889 the Johnstown flood wrought havoc upon the Pittsburg division, and necessitated strenuous work for the speedy restoration of traffic.

Mr. Brown's term of office as Chief Engineer witnessed the construction of new terminals and stations at Jersey City, at Harrisburg and at Pittsburg, of four-track stone bridges at Rockville, Pa., and at Trenton and New Brunswick, N. J., of the Trenton cut-off, from Morrisville, Pa., to Glen Loch, Pa., and of the low grade freight division connecting the middle division, on the west side of the Susquehanna River, with the Philadelphia division near Glen Loch. In 1902 he was appointed a member of the Board of Consulting Engineers in charge of the construction of the tunnel line and terminal in New York City.

Since his retirement, in 1906, from active service, Mr. Brown has spent much of his time in foreign travel, visiting Japan, Palestine, and later the continent of Europe.

Entering the profession with only a public-school equipment, his professional education was chiefly that of hard knocks and actual contact with men and things, and he was impatient of what he considered unnecessary theoretical refinement.

Of untiring energy and industry, he was perhaps chiefly conspicuous for his success in meeting emergencies and in overcoming obstacles.

Although not a church-member, Mr. Brown, during his later years, attended the Presbyterian Church in West Philadelphia.

Many engineers have their non-professional hobbies, in which they find that relaxation which leaves their forces in better shape for their more serious engagements. Mr. Brown's hobby was his work. To that he devoted his life.

He was a member of the Historical Society of Pennsylvania and of the Pennsylvania Society of Sons of the Revolution.

Upon Mr. Brown's retirement, in 1906, the Board of Directors of the Pennsylvania Railroad Co. adopted a Minute, from which the following is taken:

> In the growth and development of the transportation business in the past twenty-five years, the Pennsylvania Railroad Co. has been fortunate in having the solution of its engineering problems entrusted to such a man. Mr. Brown retires after forty-five years of active railroad work, honored and respected not only by his associates in this company, but by the profession in which he has attained the highest name and fame.

THE EXTENSION OF SEVENTH AVE., New York City, has been authorized by the Board of Estimate and Apportionment. The extension will begin at the present southerly terminus at Greenwich Ave. and West 11th St. and continue to Varick St. In addition, Varick St. will be widened from Seventh Ave. to West Broadway. It is stated that the extension thus provided will have a total length of about 1¼ miles and a width of 100 ft. The estimated cost is placed at nearly $7,000,000, of which, it is stated, half will be assessed on the district benefited and the remainder on the city at large.

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Placing electric wires underground in cities unquestionably adds to the safety of life and property and, by getting rid of unsightly poles and wires, improves the appearance of the streets. But little consideration has been given to the fact, now established, that fear of subterranean explosions may take the place of the discomfort and danger of citizens from overhead lines in times of storm or fire. Recent explosions in large cities—notably in New York, as described elsewhere in this issue—have drawn attention to this condition. It was first supposed that if the manholes were sealed no serious trouble could result above ground no matter what electrical disturbance there might be underneath. Indeed, there is reason to expect that such would be the case in streets under which there were no gas mains. Experience seems to show, however, that where gas mains and conduits run parallel near the same level, as is very common, explosions in the latter may be expected, unless special precautions are taken. Gas is almost certain, in the course of time, to diffuse itself into the conduit so that a combustible mixture collects in the manholes, there to await the static-spark discharge or the short-circuit arc necessary to cause an explosion.

What are the measures to be applied as remedies to conduit systems already built and as preventatives in work projected? First there is inspection and ventilation. If traces of explosive gases or vapors can be found in the manhole air then the manholes may need to be cleared periodically. An alternative measure is that adopted twenty years ago for the New York conduit systems—the constant maintenance of a slight plenum to prevent the entrance of the combustible gases.

New York City continues also to suffer from explosions of gasoline vapor in the sewers. No injuries or serious damages have been reported from the flying manhole covers, but that must be attributed to good luck rather than to good management. The presence of gasoline in the sewers has been blamed to the many automobile garages in the vicinity of the trouble and, while there is a law forbidding the discharge of gasoline into the sewers, there has not been as yet that inspection of sewers and garages, coupled with that prompt prosecution of offenders and with that use of every precautionary device, which would eliminate the danger.

The danger from sewer explosions will come, in most cases, from the manhole covers alone. The sewers are not sealed, as are the conduit systems, so that little or no upheaval of the pavement will be looked for. The energy of the explosion is, rather, given to the projectile-cover and it becomes even more dangerous than the disturbing upheaval of asphalt pavement about the electric-conduit manhole.

We are so young yet in the structural application of steel that whatever experiences can be gathered on the preservation or rusting of steel structures have a direct use. So in Mr. Toch's brief statement of observations on the steelwork of the Gillender Building we find valuable instruction. It is wholly reassuring in character and tells us—what many have doubted—that our magnificent creation of lofty office-building is of satisfactory permanence. We have in the past learned fairly well how rapid or how slow is the rusting away of bridges, of towers, of mill-buildings, etc.; but as to the concealed beams and columns of tier-buildings only a few scattered bits of fact have come to light. Therefore many have remained doubters, and have asked anxiously (in view of the great growth of office-buildings) for proof that building frames are not rapidly dissolving away. On the other hand the owners and custodians of these buildings have not worried sufficiently over the matter to uncover the columns and beams at a few points for a demonstration of their condition.

Now that we learn how perfect is the condition of a steel frame fourteen years old we may dismiss the question from mind temporarily, until the next opportunity is created, by the demolition of another skyscraper, for a full exposure of the steelwork. In erecting new buildings there is nothing to do as safeguard except to surround the steelwork thoroughly with cement mortar, good concrete, or well-grouted masonry; then the assurance of no rusting will be ample.

It is a little curious, in this subject, that with ample proof existing to show how permanent is steel when protected from the weather there should be any great doubt concerning this most fully protected type of steel structure. Even as regards the wall columns, there has never been any reason for thinking that more than very minute quantities of infiltration moisture could reach them, while the rest of the frame could with great positiveness be called bone-dry. In spite of this certainty the doubts mentioned have persisted, and it is well to have them laid at rest for the present by the showing of the Gillender Building.

The sanitary condition of a city is a matter of more than local interest. If it were not there would be relatively little need for state departments of health, and for less justification than exists for the valuable sanitary surveys of selected municipalities recently undertaken by the New York State Department of Health. The Bulletin of the Department for June, 1910, contains abstracts of reports made on such surveys recently submitted to the city authorities of Binghamton and Ithaca. The reports review the general conditions affecting the healthfulness of each city, the character of the water and milk supplies, sewage and garbage collection and disposal services, the general death rate, infant mortality and typhoid death rate. Pavements and street cleaning are also considered, and recommendations as to needed sanitary improvements of all classes are made.

Not many cities look after all these matters so thoroughly that an occasional general sanitary survey by trained men from outside, with general rather than local standards, will not be beneficial. Most of the minor cities of the country stand in marked need of sanitary improvements of various kinds and are almost wholly blind to many of these needs. To such, in particular, state inspection might prove of great local value, while at the same time it might lead to measures which would protect many citizens of the state at large.

The same line of reasoning would tend to justify the present agitation for the creation of a national bureau or department of health, but so broad and complex a subject cannot be discussed in this note.

The bungling way in which some of our state legislatures attempt to enact laws in the real or supposed interests of good sanitation is well illustrated by section 17 of chapter 26 of the New York Laws of 1909, "An Act in Relation to Cities." Our meaning will be clearer if we first quote this section, as recently amended by the Legislature of 1910:

(Explanation—Matter in *italics* is new; matter in brackets [ ] is old law to be omitted.)

17. Operation of crematories for disposal of garbage. A crematory *in any city or within ten miles of the corporate limits of any city*, owned or controlled by any person or corporation or by a city, for the *treatment or* consuming of garbage or other refuse matter [from any city] *or offal, dead animals or fish*, shall be so operated by the use of coke, charcoal, or other fuel device [or method] *and by such appliances and methods* that the *offensive and* noxious gases and fumes arising from the consumption *or treatment* of such garbage or other refuse matter *or offal, dead animals or fish* shall be burned or disposed of without offense *or danger to* the persons residing in the neighborhood of such crematory. The city authorities or the person or corporation owning or controlling such crematory shall cause the necessary devices, and fuel or other supplies to be furnished for the consumption of proper disposal of such gases and fumes. Any city *authority or other person or corporation owning or controlling such crematory and any city* employee or other person operating such a crematory who shall [fail or neglect to use the devices and supplies furnished for such consumption or disposal] *allow or permit such gases or fumes arising from the consumption of such garbage or other matter to escape and become offensive or dangerous to the persons residing in the neighborhood of such crematory*, shall be guilty of a misdemeanor *and shall upon conviction be punished by a fine of not less than one hundred dollars nor more than two hundred and fifty dollars for each day that such offensive or noxious gases or fumes are permitted or allowed to escape, or by imprisonment for not more than one year, or both.*

2. This act shall take effect Sept. 1, 1910.

First, we would call attention to the fact that while the section quoted is specifically declared to relate to crematories the legislature appears to have sought to extend the law to cover garbage reduction works as well, without making a corresponding change in the title of the section. This is indicated by some of the new matter inserted by amendment and also by newspaper statements to the effect that the new legislation is directed specifically to the Barren Island reduction works which treat garbage and offal from New York City. Whether or not statutory provisions relating specifically to crematories would afford a legal basis for proceeding against reduction plants, which are essentially different in design and operation, is a question for the courts to decide. There is no question but what the bill would require still another amendment to make it applicable to a crematory (whatever that word here means) which happened to be located eleven miles from a city line.

It would have been a very simple matter to have so drawn the original section as to make it apply without a shadow of doubt to any plant for the disposal of garbage or other putrescible matter or any other class of municipal refuse, whether by burning, or by any rendering or reduction process. An engineer familiar with modern methods of garbage and refuse disposal, and free from prejudice for or against any one process, would have set the framers of the bill right in the first instance. As the matter stands, the legislation is still crude and inefficient after amendment and may have to be still further amended in the future.

Aside from lack of knowledge and care on the part of the draftsman, the statute in question falls short of good legislation because it is

really aimed, largely if not wholly, against a specific plant or works, while purporting to be general in character, as ought to be the case.

We are as far from denying the rosy future of the airship as we are from prophesying the extent to which its rapid advance will revolutionize the civilization of the future, but we do view with considerable amusement the efforts of some of its promoters and devoted adherents to gloss over its obvious faults. The latest example that has come to our attention is in a defense of the ill-fated Zeppelin "Deutschland," written by a gentleman of German nomenclature, in the "Scientific American." The statement is there made that

> All the real blame [for the recent destruction of the "Deutschland"] may be placed at the door of the meteorological service. It seems hard to believe that nothing was known beforehand of a severe storm that was to sweep the country within the brief space of two hours.

We commend this to certain over-enthusiastic newspaper writers; it contains much food for thought.

The Value of Rise-and-Fall Elimination on Streets and Roads.

What is the cost of rise and fall in a street or road? How much may be spent for eliminating a hump or raising a sag in a roadway? This question, like most others in road location, is currently dealt with by judgment or intuition rather than by calculation. But it should be capable of at least approximate solution in figures, just as much so as the corresponding problem in railway location.

The question appears most strikingly in those cases where a city undertakes to remove or bypass a specially bad hill, or bridge a valley, on an important thoroughfare. The cost of such an enterprise is known quite definitely before work is begun; but the gain, while as real as the cost, is wholly unknown. The improvement is decided upon not by calculation of relative cost and gain but by impressionistic judgment, or perhaps by effect of sentiment, or for political expediency.

A notable case of an opposite kind, the *creation* of a hump being in question, came up during the recent public controversy over bridge raising in Pittsburg. The opponents of bridge raising made a strong point of the fact that at the increased elevation all the cross-river traffic would have to pass over a summit of ten or fifteen feet, additional to that already existing; and they claimed that this would impose an enormous tax on the city. Definite figures to express the loss would have made the argument undeniably forcible, while in the absence of figures it had only a personal appeal.

The problem affects country highways very widely. Of the endless succession of humps and sags on our roads, a great many could be smoothed out at moderate expense. The needless inequalities are permitted to remain chiefly because it is not realized what money value their improvement would represent. It is true that on secondary roads the need of keeping the road surface close to the level of the surrounding ground, for maintaining access, must govern in many cases; at the same time these roads are the very ones on which small avoidable humps and sags are frequent.

Of course, the rise-and-fall question on streets and roads is very often complicated with questions of steep gradient. Reducing the grade has a value of its own, and grade is so much more important than either length or rise and fall that it receives almost exclusive attention. But in analyzing the several factors they must be dealt with singly; and in many instances, as the Pittsburg case, the rise-and-fall question is practically free from grade considerations.

The frequent involvement of grade reduction, however, is doubtless responsible for a common but erroneous impression, namely: that so long as a minor hill or dip does not introduce steep gradients and thereby reduce the hauling power of the horse, it has no perceptible effect on the cost of traffic. This cannot be true unless the effects of the downhill travel counterbalance and eliminate the uphill losses, i. e., unless traveling downhill is as much easier than movement on the level as uphill travel is harder. But every one knows that a horse works best on a level, and that downhill work is somewhat harder, rather than easier.

The problem of valuing rise and fall on roads is so closely analogous to the corresponding railway problem that an approximate solution should be as readily found in the one case as in the other. Obviously the peculiar nature of road traffic complicates matters, enough so to render impossible an exact solution. An estimate of average value will nevertheless prove of great service.

A reasonable objection may be made to any attempt at figuring in this field, namely by denying the need for it. The teachings of judgment and experience, it may be said, are quite sufficient for all purposes in the case. The determination of maximum grade, and the estimation of the value of saving distance, are done well enough by the operation of judgment alone. But, taking a specific case: It is widely recognized that gradients should be adjusted to suit the character of the road surface, a hard macadam road requiring flatter grades than an earth road, paved streets flatter grades than macadam roads, and so on. This is correct enough. A simple calculation will show that to obtain equal effectiveness of hauling power we should make the maximum grade exactly proportional to the tractive resistance in pounds per ton on the level. The result of judgment is thus confirmed. Yet it is obvious that the definite relationship found from calculation is of much wider usefulness than a mere general appreciation that hard roads should have flatter grades than heavy roads; and the utility of making such calculation needs no defence in view of the result. Moreover, we can determine by our calculation what gradient should be used on one kind of road to give an effectiveness corresponding to that of another kind of road of stated maximum grade—a result which could not be obtained at all by mere intuition. It is likely, therefore, that in considering rise and fall we will also obtain a more useful result by calculation than by the simple exercise of judgment.

Proceeding, then, to consider the cost of rise and fall, we employ the following facts and principles: A country road will give an average tractive resistance of 100 lbs. per ton. To lift a load 1 ft. will then consume 20 times as much work as hauling it horizontally 1 ft. In other words 1 ft. of rise is equivalent to 20 ft. of level haul. To travel over a 100-ft. length of road having a rise of 5 ft. puts a tax on the motive power equivalent to 100 ft. of level haul plus the lift equivalent of 5×20 ft., a total of 200 ft. of level haul. In descending this hill on the other side, the effect of downhill travel needs to be counted; and as before remarked a horse moves downhill less easily than on a level (at least on any but very flat grades). Having regard to the average gradients occurring on roads, we may say that downhill movement requires a slight allowance over level movement, though, of course, much less than the uphill allowance. A distance of 5 ft. per foot of fall is probably ample for this purpose in the extreme case, while at low gradients no allowance at all need be made. Summing, we have, as the total allowance for 1 ft. of rise and fall, a distance of 20 to 25 ft. of level haul. This means that a hump or a sag of 20 ft. in a road puts the same tax on the horse as an extra haul of 400 to 500 ft.

Such a computation is not vitiated by the fact that, in ordinary road work, neither rise and fall nor unnecessary length of road is given much attention as an obstacle to traffic; for instance, wasted distance is objected to more because of the additional first cost of road than because it puts a needless burden on the traffic. That they do lay a tax on traffic remains undeniably true, however. Every hump or sag has to be climbed by each passing vehicle at the cost of a fairly definite amount of wasted work, and somebody must pay for this wasted work. It should be realized that if a road contains only 20 ft. of wasted rise and fall in each mile, the effect is to increase the equivalent distance of all hauling by 8 to 10%. The cost of the hauling would be increased in nearly the same ratio, on the average.

Horse-drawn traffic is governed by the working capacity of the horse. The horse's daily capacity is not an inexhaustible fund, and its limitations determine the cost of hauling. If a given haul of ten miles puts 10% more demand on the horse than another haul of the same length, it is certain that in the long run the former will cost proportionately more. This alone gives value to the above figure and enables it to be converted into an equivalent money figure.

Take the value of one horse, wagon and driver at $3 per day. The average distance covered per day, at a high estimate, may be set at 20 miles. On this basis each mile of distance per horse costs 15 cts.; 20 to 25 ft. distance costs 0.6 to 0.7 mill. This latter distance was found to be the equivalent of 1 ft. of rise and fall. Rise and fall of any other amount will cost in proportion. Thus, 10 ft. of rise and fall will cost 0.6 to 0.7 ct. per horse. If we use a value of ½-ct. for 10 ft. of rise and fall we will be on the safe side.

From a unit-value so computed, the cost of any given hump or sag in a road carrying a known amount of traffic is readily derived. Thus, suppose that a road carries a traffic of 50 horses per day in full hauling service, and the road contains a 10-ft. hump. This hill imposes a daily charge of $50 \times$ ½-ct. or 25 cts. For a year of 300 days the charge will amount to $75. Eliminating the hill will save this amount each year. Now, what investment is justified to secure a saving of $75 per year? Maintenance being not appreciably affected by the presence of the hump, we have only to capitalize the annual charge. At an interest rate of 6%, for example, the capitalized value is $1,250, and if it should cost only $1,000 to take out the hump there would be distinct profit in making the improvement.

For city streets this calculation must be modified to suit the lower tractive resistance of pavements. Thirty pounds per ton is a fair value for the traction on a well-paved level street. But as pavements are not always in best condition, and weather conditions also may increase the resistance or decrease the hauling power, a value of 40 to 50 lbs. per ton will be a better average assumption. Taking the higher figure, 50 lbs. per ton, we note that this is one-fortieth of the resistance of a straight lift. Then the work of lifting a load 1 ft. is equivalent to the work done during a level haul of 40 ft. The flat grades prevailing in cities render a downhill allowance unnecessary, and we have, therefore, as the equivalent of 1 ft. of rise and fall a level haul of 40 ft.

The value of a mile travel of a horse in city hauling is rather indeterminate. To take the same figure used for country haulage, 15 cts. per mile, will surely not err through excess. On this basis our 40-ft. equivalent of 1 ft. rise and fall is worth 1.1 mill per horse. The annual cost of 1 ft. rise and fall for one horse per day, 300 days, is 33 cts. Capitalizing this amount at 5% interest (for city conditions), we get $6.60. Any specific example can be computed from this value by direct multiplication. If the traffic on a street averages 100 horses per day (counting only those in all-day or maximum service), a hill or sag of 10 ft. may profitably be eliminated if the work costs less than $100 \times 10 \times \$6.60$ or $6,600.

Rise-and-fall problems in cities are further affected by a factor foreign to country-road traffic. With very few exceptions every route in a city is bypassed by a great many others, and if a serious obstacle, as a high hill, exists in the direct route the traffic naturally belonging to it will go around by other streets, preferring the longer distance to the hill on the short route. It may happen, therefore, that a particular hill may show a very small traffic, not enough in fact to make its improvement appear justifiable on calculation. But it is possible that a much heavier traffic would seek this street after elimination of the hill. Now, neither the small original traffic nor the heavy final traffic should be used in computing the charge to be laid against the hill, but some intermediate traffic figure. In default of special reasons for choosing a par-

ticular intermediate traffic, the mean of the original and final would be taken.

Thus, suppose a gorge is to be bridged, where the existing road, while not of prohibitive gradient, yet discourages traffic sufficiently to carry practically none, all traffic seeking the bypassing routes. It may appear probable that the bridge when built will secure the whole traffic normal to this point, say 100 one-horse loads per day. The tax on this traffic prior to the construction of the bridge evidently is not as great as if the traffic had actually traversed the gorge, since the other routes are easier. Unless we have more specific knowledge, we must assume as most probable that the average tax on the traffic by going over these other routes was substantially one-half the tax which the gorge would have imposed. Then if the gorge is 80 ft. deep, the charge must be, not that of 80 × 100 units, but only one-half this amount or 4,000 units. The capital value per unit being $6.60, the maximum expenditure justified by the present traffic is $26,400. This is a mean between the figure zero for the original traffic (none), and $52,800 for the final traffic (100 horses under full service saved 80 ft. of rise and fall, per day), and is obtained directly by crediting the full saving of 80 ft. rise and fall for the mean of original and final traffic (50 horses). Such a traffic adjustment, or a similar one, must be resorted to if the loss-and-gain comparison is to have any meaning in these special cases.

In conclusion, it is submitted that the calculation of cost of rise and fall affords a far surer guide in actual problems of street and road improvement than the most skilled judgment. Without lessening the field for exercise of judgment, or attempting to substitute mechanical rule for proper discretion, it states certain of the determinative factors in such manner as to reduce the chance for error in drawing conclusions.

It should not be forgotten that the above analysis leaves out of account the very frequent interlinking of grade questions with those of rise and fall. Nearly every rise-and-fall elimination will also entrain a reduction of grades; and a gain due to the flattening of gradients will then be added to the saving in rise and fall. But even if the grades remain the same, the amounts of saving above deduced will still be realized. These are therefore *minimum* estimates of the gain accruing from elimination of rise and fall.

LETTERS TO THE EDITOR.

The Deepest Current-Meter Work and the Depth of Mean Velocity; Mississippi River Commission Gagings.

Sir: In your issue of June 30, page 733, quoting from Water Supply paper No. 252, U. S. Geological Survey, you state as follows:

> This involved the use of the meter at the maximum depth of 90 ft., which is believed to be the deepest current-meter measurement yet recorded.

In the discharge measurements of the Mississippi River near New Orleans, made under the direction of the Mississippi River Commission, the current-meter has frequently been run at depths greater than 100 ft. In the locality named the maximum depth of water reaches 180 ft., and the mean depth of the entire cross-section exceeds 100 ft.

In 1883 a large number of measurements at vertical intervals of 5 ft. or less were made to determine the form of the vertical velocity curve. While it is by no means regular, as in streams of moderate depth, it could hardly be called straight but the curve is accentuated near the top and bottom as you have stated. The result of this elaborate series of observations fixes the line of mean velocity at 0.63 of the depth, below the surface. This value is regarded as essentially correct and no valid reason is apparent for rejecting it.

J. A. Ockerson.

St. Louis, Mo., July 6, 1910.

The Scoop-Wheel Pumping Plant at Schellingwoude, Holland.

Sir: All pump specialists will thank you for your article of May 19, describing the "Scoop-Wheel Pumping Plant at Schellingwoude, Holland." One question is therein unanswered. Does the "movable breast" B. B. Fig. 2, support itself by a net flotation or by a counter weight? It would also be of interest to know how far from tangent position this "movable breast" would stand during actual work.

As engineer of one of the two firms which competed for the drainage installation for the city of New Orleans, it was my privilege to figure on many centrifugal pumps of unprecedented size and low lift.

It is known that the efficiency of these centrifugals was not high, and it seems certain that these Dutch scoop wheels would have been a better and cheaper and more efficient installation than the expensive centrifugals actually built, especially as their duty was merely to give an out-fall hydraulic grade for storm water, which involved a lift of but 3 to 6 ft.

Yours very truly,

H. S. Wood, M. Am. Soc. M. E.

Park Row Building, New York City, May 21, 1910.

[We have submitted Mr. Wood's inquiries to the author of the article in question. Professor Slichter's reply is given below.—Ed.]

Sir: I regret that my absence from the country has caused unreasonable delay in receiving the foregoing letter.

The movable breast used in connection with the Schellingwoude scoop-wheels possess a slight flotation. I believe, however, that counter weights would not be necessary unless the breasts were constructed unusually heavy. Any hinged surface, such as the movable breasts described in my paper, tends to arrange itself along the surface separating the dead water from the principal current. Some interesting illustrations can be had by tacking a small square piece of canvas to the edge of a wooden block and placing both in various positions in a swift current of water. The "suction," as the usual operating mechanic delights in designating such effects, will be seen to throw the canvas into the curved surface of the dead water, and there hold it against any moderate attempt at displacement.

Very respectfully yours,

Chas. S. Slichter.

Madison, Wis., July 2, 1910.

An Underwater Pile Saw of Twenty Years Ago.

Sir: I have just read Mr. Clarence Coleman's interesting account, in the June 16 issue of Engineering News, of the method he used for sawing piles under water at Superior Entry, Wis., together with your footnote stating that a somewhat similar machine was used at a bridge from Boston to Cambridge, across the Charles River, in 1901.

Mr. Coleman's article recalls to my mind a machine, exactly similar to that referred to in your footnote, which was used for cutting piles under water at the Yazoo River (Miss.) drawbridge in 1888 or '89. At that time I was an assistant engineer on the old Georgia Pacific R. R. (now the Southern Ry.) and was stationed at the Yazoo bridge. In this case, the same scow, engine, and boiler used for driving the piles were afterward rigged up to saw them off.

The apparatus was designed by Mr. P. B. Houston, Resident Engineer, and Mr. J. H. Rousseau, Superintendent for the contractors, A. V. Gude & Co. The water was about 20 ft. deep, and the current very swift, being from 4 to 5 mi. per hr. As far as I was able to determine, I think, the heads of the piles did not vary in height by more than ½-in. between the highest and the lowest.

Mr. Coleman's method, however, should give almost absolute accuracy, as there seems to be no chance for variation in elevation with the guide trolley, of his device, resting on the level cap.

H. F. Wilson, Jr., M. Am. Soc. C. E.

Birmingham, Ala., June 20, 1910.

Light-Draft Steamers for Shallow Rivers.

Sir: I was much interested in Mr. Sweeney's article in your issue of May 5, 1910 (p. 512), on "The Most Economical Type of Boat for Operation on Western Rivers with an 8-ft. Channel Depth." I was "raised" on the Missouri River. My father was an old river captain and owner, and during my earlier years I spent much time on the river with him. Since then I have kept in touch with river practice and development, and have written some articles and papers on this subject. The general tenor of my writings has been in defense of the Western river steamer, as being peculiarly well adapted to the trying conditions imposed upon it. I have not been able, however, to close my eyes to the fact that many developments in mechanical engineering which have proved advantageous in stationary practice, and in marine service elsewhere, and which promised well for river practice, have met with no encouragement.

Mr. Sweeney's standing and experience entitle his views to the most serious consideration, and yet it seems to me that he leans to the side of that extreme conservatism which is to some extent responsible for the slow development of our river steamers. It is exceedingly strange that in this year of our Lord wooden hulls without compartments should find a defender among engineers, and that the slow-speed wasteful steam engine commonly used should be commended.

I am unable to agree with Mr. Sweeney as to the commanding position of the stern-wheel boat in river service. It has by no means displaced the side-wheel steamer in this part of the country. The Eagle Packet Co., and the Wiggins Ferry Co., the largest and most active companies in this vicinity, operate both types, but are confining their newer boats to the side-wheel type. The Eagle Company's latest boat, the side-wheeler "Alton," is the fastest steamer in this harbor, and gave a highly satisfactory account of herself in the Presidential trip to New Orleans last autumn, in which there were many boats of both types.

That the stern-wheel boat even if equipped with the latest and best form of balanced rudders, can compare in steering ability with the side-wheeler with independent engines, will surprise most river men. The stern-wheeler must have more or less headway to handle itself properly, can turn only in arcs of long radius, and is much affected by winds. The side-wheeler needs no steerage way, can turn in her own tracks, and is largely independent of wind. To trim a stern-wheel vessel the boilers must be located at a long distance from the engines, thus lengthening pipe lines and increasing condensation and pressure losses—as well as preventing proper supervision of the firing room by the chief. In the side-wheeler all the machinery can be located compactly near the center of the boat. It was these considerations which led to the adoption of the side-wheel type rather than the stern-wheel by the recently organized Mississippi Valley Transportation Co.

The considerations which have given the stern-wheel boat such prominence as it has attained, are not the balanced rudder alone, as claimed by Mr. Sweeney, but, first, the lighter draft of such steamers, and second, the fact that only a single engine crew is required. In the later forms of side-wheel steamers, represented by the ferry "Andrew Christy," of St. Louis, the independent side wheels are driven by geared compound engines, the controlling levers of both of which are operated by a single engineer, located at a central point. She is furthermore one of the lightest draft steamers on the river.

Furthermore, the side-wheeler is better adapted to making down-stream landings with stern up-stream, as there is no wheel there to interfere. If any stern-wheel packet boats are regularly making such landings in swift rivers, it has not come to my knowledge.

It is true that it does not always pay to use the most economical type of boiler and engine. Each case must be worked out for itself. The objection to the present single-cylinder engine is not alone the high clearance, but the low piston speed, and necessarily late cut-off, high terminal pressure, and consequently high water rate. These objections are all met by the higher-speeded engines geared directly to the side wheel, a construction of course impossible with stern wheels. The higher speed tends to reduce weight, and the greater efficiency reduces the boiler power necessary. The great importance of lightness, the low cost of fuel, and value of simplicity and small space occupied, the small number of hours of service per year, all must be considered.

Very truly yours,

William H. Bryan, M. Am. Soc. M. E.

Lincoln Title Guaranty Bldg., St. Louis, Mo., June 25, 1910.

The Water-Power Situation in Wyoming.

Sir: You are to be congratulated for the sane discussion of water-power development which appeared in your editorial columns on June 23. More misconceptions prevail relative to this branch of engineering than can be enumerated in a brief letter. Of recent years an effort has been made to show the reading public that our coal supply is rapidly diminishing. All engineers that I have been able to see seem to feel that the statistics should be sufficient to allay all fears. Coal is being discovered every day and valuable deposits are shown to exist at depths which are not workable at the present time owing to the competition of mines that can be more cheaply maintained on a commercial basis. The visible coal supply is sufficient for a thousand years or more and we must admit that we are very ignorant as to the ultimate extent of the coal fields of the earth.

There are many sources of power, light and heat. Scientific investigation will probably multiply these as the demand increases. If the people now alive or their immediate successors were in danger of a fuel famine, there would be some reason for the hysteria which has been so prominent during the past two years. I can attribute the present misunderstanding to nothing else than the political activity of federal officers who have more concern for their own welfare than they have for the truth or the prosperity of those who must depend upon the use of natural resources for a livelihood.

I wish to set forth briefly the water-power situation in Wyoming. Our streams are large and our mountains are high. Our principal water-supply comes from the high mountain areas. The precipitation which falls annually would cover Wyoming (an area of 63,000,000 acres) to a depth of considerably over 1 ft. Our stream

measurements show that over one-sixth of this actually flows away in our creeks and rivers. We have a total stream discharge averaging about 15,000 cu. ft. of water per sec. of time, throughout the year. This water has a mean fall from its source to the state line of considerably over 4,000 ft. It would not require many lead pencils to compute from these figures a total of something like 5,000,000 to 6,000,000 HP. These matters do not worry the people of Wyoming.

Under our state laws water for power purposes is an inferior right to the use of water for domestic and irrigation purposes. Irrigation is so much more important than power development that it is impossible to stir up an argument of the principles involved in connection with the two uses, among those who understand our conditions. Water-power will always be developed above irrigation reservoirs where the water may be used without interfering with agricultural growth. To-day water-power is not a necessity and there is no special demand for water-power projects. A market for power must be created before it is wise to invest money in water-power machinery and in transmission lines. This probably sounds like a quotation from a primer to engineers but it embraces economic and business ideas that are not discussed by those who have been trying to make us believe that the water-power of the country is to be monopolized.

To-day the state of Wyoming is making every effort to secure the construction of irrigation works that will prepare the way for the farmer. We have millions of acres that only need water to be productive. No one can compute the value of water when applied to arid lands. We say that it immediately makes dollar lands worth $40. We cannot say what these lands will be worth in five years or ten years. We cannot estimate the value of the industries allied with agriculture. We cannot say what will be the wealth of cities and towns. We cannot place a figure on such a civilization as an irrigated district always supports. This cannot be accomplished without water for irrigation. It can all be accomplished without water-power. Yet under the Wyoming laws we will see to it that the water-power plants are so located that the use of water for power purposes will not interfere with agricultural development. By such an administration the irrigated lands will support a population that will be protected by an ample water-supply for the growing of crops and at the same time power from the falling water in the mountain districts will be available. This will be done if the plans of the state are not interfered with by the withdrawal of lands which will make irrigation development impossible because the Federal Government may have the power to prohibit agricultural growth in order that water-power may be preserved for posterity.

We have examples of this kind at the present time. In a county where a million horsepower can be created from the waters of mountain streams, the general government now threatens to hold a reservoir site, which is essential for the reclamation of 100,000 acres of land, because of possible power values.

The Federal Government can only withdraw lands. It cannot control the waters of streams and lakes. The state has reserved this right. The withdrawal of lands simply means stagnation in every line of development. Irrigation is impossible and the development of power is made more impossible than it is at present. The state retains all uses of water subject to legislative control. Should any water-power development ever become a burden, in any way, on the people, the state can relieve the situation. The withdrawal of lands is not a remedy.

It is difficult to lead a reader, not acquainted with Western conditions, to understand how little reason there is for fear that water-power is to be monopolized.

No Eastern states that we know of have such a control of water as has Wyoming. No investigator from the East who has studied our laws and our administration and who has become acquainted with conditions, has any patience with the "conservation" movement in so far as it applies to this state and to other states in the West. Yet the effect of this agitation is still manifest. Men who know nothing about the needs of the inter-mountain region and who have absorbed the water-power arguments without being able to understand them, hold responsible positions at the National capital where they can by a word or by the stroke of the pen withdraw large areas from entry and make it impossible for the homeseeker to find a place where he can maintain himself.

This kind of administration on the part of the Federal Government is driving the bone and sinew of our youths from the rural districts to Canada where, although the winters are long and conditions are not so inviting, yet the Government is liberal towards every man and every agency that promises development. How long will the United States be swayed by the noise of the political alarmist? When will common sense supplant dreams and idle theories? Those who are interested in the prosperity of the West—a new country that can only develop by overcoming many natural obstacles—hope that the nation at large will soon stand with the Western states in an effort to make every available acre perform its part in supporting such a civilization as has been created in Eastern states, where wiser policies prevailed during the early development period.

Sincerely yours,
Clarence T. Johnston, Mem. Am. Soc. C. E.,
State Engineer.

Cheyenne, Wyo., June 25, 1910.

[Congratulations are dear to the hearts of all truly human beings, editors not excepted, but in congratulating us for the stand taken in our issue of June 23, Mr. Johnston has unintentionally conveyed the idea that we were writing in opposition to the country-wide movement for the conservation of natural resources—national, state and private. Nothing was further from our thoughts. In our allusion to the conservation movement as related to water-power (an allusion quite incidental to our main thesis) we merely called attention to certain generally overlooked limitations as to the actual value of water-power *to-day*. Nor in publishing Mr. Johnston's letter do we mean to endorse what he says regarding either the coal supply or the motives of those government officials who have taken a part in the conservation movement.

We take pleasure in giving space to the letter because it contains an interesting and forcible exposition of the principle that water is a valuable asset and should be put to its highest beneficial use. What such use will be varies widely in different parts of the country. In Wyoming, at least for the present, irrigation has first call on water. It is quite conceivable that in a few years water-power will rival irrigation in some sections and that ultimately water for city supplies will take precedence over both irrigation and water-power in some parts of the state.

A wise view of conservation will take into consideration all the possible uses to which water may be put in the near future, and will not ignore the probable needs of more distant times. Moreover, in so far as the nation has an interest in the waters or other natural resources of the public lands its representatives are in duty bound to take a broad view of the disposition and control of those resources, not only as against private interests but also as against the public interests of a small portion of the nation, be that portion a single state or a group of states.—Ed.]

The International Congress of Mining, Metallurgy and Practical Geology at Duesseldorf, Germany.

(Editorial Correspondence.)

Fifteen hundred engineers interested in mining and metallurgy and the machinery used therein assembled from all the nations of Europe. That was what I found at Düsseldorf, Germany, when I arrived there from the United States on June 21. I say from all nations of Europe, because, although the invitations to the Congress were world-wide, the representation from North America was very small, barely a half-dozen all told. Of course this is far from strange since few engineers could undertake a three-thousand mile journey across the Atlantic plus more or less land travel at each end of the voyage to attend a four-day convention, no matter how attractive. The Americans in attendance, therefore, were those who were in Europe for other reasons. Honorable exception should be made, however, of Prof. Jos. W. Richards, of Lehigh University, who contributed two papers to the Congress, came across the ocean solely to attend it and sailed on the return voyage soon after its close.

The papers read and discussed at the Congress were by German engineers. This admittedly added to their value, as Germany is in the foremost ranks in all technical matters relating to mining and metallurgical practice.

The Congress met for its technical work in four separate sections, devoted respectively to mining, theoretical metallurgy, practical metallurgy, applied mechanics and geology. The total number of papers on the program was about one hundred, but a number of these were not received in time for presentation. By thus dividing the work among the different sections, the papers were taken up and disposed of in three sessions, two held on Monday and one on Tuesday morning, thus leaving the remainder of the time free for the excursions.

These excursions were doubtless the most important feature of the Congress and were the chief magnet in drawing to Düsseldorf so large a number of prominent engineers from all over Europe. The number of foreigners (i. e., other than Germans) registered in attendance was about 700.

As some of our readers doubtless know, Düsseldorf is the chief center of that busy hive of industry around the lower Rhine which includes within a small area such well-known towns as Essen, Barmen, Elberfeld, Dortmund, Mulheim, Oberhausen, Duisburg, Ruhrort, Bochum, Hörde, etc. Iron and steel furnaces, foundries and machine shops are seen on every hand as one crosses this district by rail.

German industrial plants are by no means freely open to visitors. It was therefore a great feat of the Congress managers that they succeeded in arranging for no less than 40 excursions to such plants, covering a great variety of works and mines, etc. Those registering in the Congress gave notice in advance which excursion they preferred to join, with second and third choices, so that the excursions might be participated in by groups of convenient size.

It is of course as impossible, within adequate limits of space, to describe the field covered by these forty different excursions as it is to summarize the contents of the hundred and more papers. It may be remarked, however, that many of the visitors wished they were possessed of dual, or better quadruple, personality, so that they might attend several sessions or take part in several excursions simultaneously.

Turning next to the social features of the occasion, it would be difficult to emphasize too greatly the hospitality with which the visitors were entertained by their German hosts. Immediately on his arrival at Düsseldorf the visitor was notified that he was to take part in an unusual event. In the center of the park in front of the railway station a large sign-board had been erected bearing the words "International Congress." This sign was not a cheap, tawdry-looking affair, like a bill-board or the strips of cotton cloth with "Welcome" painted on them which might do duty on such an occasion in an American city. It was skilfully and artistically framed in and supported by evergreens, so that it was in entire keeping with the park in which it stood and had in fact somewhat of the air of having sprung up there naturally, like a shrub or a tree. I emphasize this trifling matter because it is so typical of the thoroughness that one sees everywhere in the land of Germany. It is not enough here that a thing shall be useful or shall answer the purpose. It must be artistic as well. A thing must be done thoroughly, if it is done at all.

It is necessary to digress also to say a word or two about Düsseldorf. What kind of a city is it? Well, it is the kind of a city that subscribed a sum which I have heard estimated as forty to fifty thousand dollars toward the expenses of this Congress. It is a city, moreover, which does things of this sort not at all infrequently. When an American is told that Düsseldorf is a great iron and steel manufacturing center there rises before him naturally a picture of such a city as ——, but it is needless to mention names. We all know what a forlorn desert of a place most of the cities in our own iron and steel manufacturing districts are.

From such nameless metropoli as these, Düsseldorf stands at the farthest possible remove. The city which it most resembles is Paris. It is as free from smoke as a New England country village, notwithstanding the very soft coal fuel used in this locality. The iron and steel works are miles away from the central part of Düsseldorf, and German practice is too skilful to permit serious offense in the making of smoke. Its pavements (mostly of stone blocks) are smooth as are the pavements of not one American city

that I know, and they are also cleaner than those of any American city of my acquaintance.

This much it seems necessary to set down to give the reader a picture of the Congress. It is now necessary to add a word as to the building in which the sessions were held and in which the social events took place.

This was the "Tonhalle." To tell what the "Tonhalle" is it must be explained that a German city considers it as much a municipal function to provide proper amusement for its people, as to pave the streets.* The Düsseldorf "Tonhalle" is a municipal concert hall, a large, handsome building containing spacious auditoriums, the largest of them supplied with stage and galleries but with a level floor so that it can be used for dancing, dinners, etc. Rooms for receiving and checking wraps for an audience of a thousand or more are provided and also very large rooms for catering and serving, since eating and drinking are an essential part of every festal occasion in Germany. At the rear of the building is a park filled with fine trees under which are hundreds of tables, sufficient to accommodate an assembly as large as the halls inside the building can hold.

As stated above, the headquarters for the Congress were established in the "Tonhalle." Here the Sections held their meetings and here the members were entertained at luncheon on Monday, the opening day; and in the evening were tendered a reception by the city of Dusseldorf.

On Tuesday evening a dinner was given to the members of the Congress served in the "Kaisersaal" and the adjacent "Rittersaal," in each of which a military band was in attendance.

Each guest of the thousand and more who were seated at the tables was assigned a seat with especial care that he should have neighbors speaking the same language. Those who have wrestled with the problem of seating the guests at a public dinner can imagine the added difficulties of arranging the seating where those in attendance speak half a dozen or more different languages, and most of the guests are total strangers to each other. But European engineers and Europeans generally have linguistic accomplishments that are a perennial surprise to Americans.

I shall not hunt for adjectives to describe the menu of the fine dinner and the elaborate table decorations or the after dinner toasts and the enthusiasm with which they were greeted. I prefer to take the space to describe the unique event that followed the dinner. The menu-card bore the simple announcement, "After the banquet a little festive play will be performed on the stage of the Kaisersaal."

Following the anvil solo from "Siegfried," the curtain rose on a scene which was as good a representation of the interior of a modern steel works as was ever put on the stage of a theater. In the foreground was a huge bridge crane, beneath it a full-size steel works ladle and steel ingot molds. In the background smiths were busy at a forge and the smoke, flame and sparks of a modern steel works were reproduced with remarkable faithfulness.

A group of workmen, representing the different industrial nations, dressed in usual workmen's clothes, gather round the superintendent of the works, who declares that he wants some steel made which shall be superior in quality to any ever produced. They agree to undertake the task. The traveling crane picks up the ladle and swings it to one side where a cupola is tapped and a stream of molten metal is run into the ladle with the usual accompaniment of scintillating sparks. After the ladle is full the stream is stopped (which necessitated the pulling back of the incandescent cylinder representing it into the cupola!). The traveling crane then hoists the ladle and swings it over an ingot mold. The bottom of the ladle is tapped in regular fashion and a stream of glowing metal (apparently) poured into the mold. Then the stream was cut off, the ladle was set one side and the crane picked up the great tongs to lift the mold off the ingot. Then came the climax. Instead of a glowing slab of hot metal the lifting of the mold revealed a beautiful girl, dressed in flowing white robes. In an impassioned address to the workmen and the audience she declares that the technique—the applied science of modern industry—is a tie of steel uniting in a fraternal bond all the nations of the earth.

This brief outline cannot pretend to do justice to the exquisite artistic effect with which this little play was produced. In one sense it was an unimportant part of the week's program; but it shows what large labor and expense our hosts undertook to make our entertainment perfect. It reveals also, I think, something of the fondness of the German for art and literature. Just as they decorate every utilitarian structure, they weave around the prosaic affairs of industry and commerce a tissue of romance and legend.

I have passed over the after-dinner events without notice; but one of them cannot be passed over. That was the reading of a telegram from Count Zeppelin at Lake Constance, saying that if the weather continued favorable, he would come to Düsseldorf in his latest airship on the next day.

I have indicated that the city of Düsseldorf took a great interest in the Congress; but it took far greater interest in Zeppelin and his airship even though it is no longer a novelty there. On Wednesday, as the hour of noon approached, the streets of Düsseldorf were filled with people scanning the sky to the southward. Promptly at 12 the big balloon came in sight and passed directly over the central part of the city at a height of about 300 ft. The noise of the machinery and the propellers was plainly audible to those on the streets below. After passing over the city the airship came down in a field in the suburbs, where a huge balloon shed has been constructed for it.

I may add here that a similar balloon shed has been constructed at Cologne and the company which now owns this latest Zeppelin airship proposes to carry passengers between Cologne and Düsseldorf this summer. The fare charged is $25 one way. The following Sunday, which I spent in Cologne, was widely advertised as a day on which regular flights would be made between the two cities. There was an eager crowd of passengers ready to pay the fare; but the day was one of frequent showers with accompanying gusty winds and the airship did not appear.

Admittedly these huge dirigible balloons are fair weather machines and not safe in even moderate storms.* This does not detract, however, from the real engineering feat which Count Zeppelin and his associates have performed in making a rigid structure of the huge size required for these balloons and at the same time light enough to be lifted by the buoyant gas.

All this about Zeppelin may seem like a digression from the story of the Congress, yet it really is not, for he was the central figure in the chief social event of the following day. This was an evening steamboat excursion on the Rhine. At the hour set for the party to assemble at the steamer landing, a heavy rain was falling. (In fact it has rained in Germany every day save one since I landed at Antwerp on June 21.) But a trifling matter like a little rain does not discourage these enthusiastic Germans. Word had gone around that Zeppelin was to go on the steamer with us and the streets along the river bank were black with thousands upon thousands of people eager to catch a glimpse of Zeppelin, or at least of the boat on which he was. After everyone else was on board an automobile came dashing along the river street to the boat landing, and as the guest of honor came on board the crowd cheered itself hoarse. All along the river bank salutes were fired from yacht cannons. As the steamer left the wharf and steamed slowly along the water-front the streets, housetops and every possible viewpoint were blocked with cheering multitudes. Excursion boats and tugs, crowded to the guards steamed alongside to get nearer the center of attraction. The Rhine was in high flood and flowing past the city with a turbulent current of at least five miles per hour; but half a dozen young men stripped of clothing swam out into the chilly stream for the sake of waving a small flag at Zeppelin and yelling as the current swept them down past the steamer.

The current idea that the German is phlegmatic and unemotional seems absolutely contradicted by such a display as this. I search my memory in vain to recall any American inventor who has received such a tribute of popular enthusiasm.

Our steamer sailed down the river while Count Zeppelin held an impromptu reception of the Congress members. When I had the privilege of a few minutes' visit with the Count, he told me that during the Civil War he was commissioned by the German government to study the military operations of America. He became acquainted with most of the prominent generals, and still has a permit signed by President Lincoln allowing him to pass through the Union lines.

After darkness had fallen (which does not happen here at this season till nearly half past ten) the steamer turned back to Düsseldorf and we witnessed a fine display of fireworks.

The concluding event of the Congress and final formal session was held on Thursday afternoon at Essen. Essen is identified in the minds of most Americans with the Krupp works. I had made allowances for Düsseldorf as an art and literary center, attractive for residence to wealthy men. Essen, however, I had thought of as a purely manufacturing town, and I had no expectation of finding much in the way of attractive streets or buildings at Essen, except perhaps a German reproduction of a Carnegie library and of course the famous model tenements of the Krupp workmen. I was surprised, therefore, to find at Essen streets upon streets lined with stately buildings, streets as well paved as those of Düsseldorf; also parks and playgrounds such as very few American cities of five times the size can show.

The members of the Congress, assembled at Essen from various excursions in the late afternoon, met in a fine hall in the building of the Rhenish-Westphalia coal syndicate—a sort of German coal trust. Brief addresses were made by representatives of the several nations sending delegations to the Congress and by others, and a permanent organization was formed which will have the responsibility for the conduct of future Congresses. It may be explained that the two previous Congresses, held at Paris in 1900 and at Brussels in 1905, adjourned without definite provision for future sessions.

Invitations were presented from the principal engineering societies of England in response to which it was decided to hold the next session of the Congress at London in 1915.

I have spoken of what Düsseldorf did to entertain the Congress. The city of Essen raised forty thousand marks to give the visitors one evening of pleasure. (A mark is equivalent to an American quarter in international exchange; but in Germany it means nearly as much as one dollar.) In the great city concert hall, tables were spread for the whole party with food and drinks galore. The beautiful park adjoining was decorated with thousands of Japanese lanterns. Bands played in the hall and in the gardens, an orchestra furnished music for dancing in a special pavilion erected for the occasion. The whole was a fitting climax and conclusion to the International Mining Congress of 1910.

But the most impressive thing to me was the city of Essen itself and the contrast between this German industrial town and our typical American cities in the iron and steel districts. Mr. Frederick C. Howe, of Cleveland, in one of the recent magazines, has told a most interesting story of what modern Germany has done in city

*Besides the "Tonhalle" the city owns a magnificent theater.

*On the very day these words were written, as I subsequently learned, the Zeppelin airship "Deutschland," to which reference is made, was wrecked and its passengers narrowly escaped with their lives. [See p. 764, Eng. News, June 30, 1910.] An attempt was being made to show the power of the airship to make headway against an opposing wind. It developed that a speed of only 5 or 6 miles an hour could be made. Soon one of the motors broke down and the ship was swept before the wind to the eastward for nearly a hundred miles from Düsseldorf, the starting point. After ten hours the ship was wrecked in a treetop.

FIG. 1. GILLENDER BUILDING; STEELWORK DOWN TO FIFTEENTH FLOOR.

(Trinity Building, 111 Broadway, in left background beyond American Surety Building.)

FIG. 2. GILLENDER BUILDING TAKEN DOWN AS FAR AS ELEVENTH FLOOR, VIEW TAKEN LOOKING AT SOUTHEAST CORNER.

(American Surety Building, 100 Broadway, in left background; Hanover Bank Building, cor. Pine and Nassau, in right background.)

building. I am in a mood to particularly commend Mr. Howe's article to the readers of Engineering News. Certainly these German cities with their well-paved and clean streets, their beautiful municipal buildings, parks and playgrounds, their cultivation of municipal pride and public spirit, are an object-lesson well worth the unprejudiced study of every thoughtful American.

C. W. B.

Mayence, Germany, June 28, 1910.

The Condition of the Steel of the Gillender Building; A Preliminary Report.

By MAXIMILIAN TOCH.*

The Gillender Building, at the corner of Nassau and Wall Streets, New York City, was erected fourteen years ago. It was the first skyscraper erected in New York, being 20 stories high. (16 stories and 4-story tower). It is the first skyscraper to be demolished. Prof. Chas. Baskerville, Director of the Department of Chemistry, College of the City of New York, suggested that I make a very careful examination of the condition of the paint and the steel as the building was being razed, and to that end he obtained permission for me, from Messrs. Marc Eidlitz & Son, the architects of the new building to be erected on the site, to examine and photograph the steel. At this writing, June 30, it is too soon to give anything but a preliminary report, as the foundation steel has not yet been uncovered, but several valuable and important lessons are to be learned from the examination of this steel as it is being uncovered after a lapse of fourteen years.

THE STEEL WELL PRESERVED.—Most important of the facts learned is that the steel, per se, is in a *remarkably good state of preservation*. There may have been a number of rivets which were largely corroded, but I was only able to find two that showed anything like progressive oxidation.

The factor in the construction of the Gillender Building which accounts more than anything else for its perfect preservation was the rather unique combination of architect, steel constructor and builder. Mr. Charles I. Berg was the architect—a very careful and experienced man. Mr. Charles T. Wills, the builder, has a reputation for exceedingly careful work. Post & McCord, the steel constructors, have been identified with some of the largest operations, and follow out specifications very carefully. The combination of such talent had much to do with the preservation of the building itself.

THE PAINT DESTROYED.—The specifications for the painting of the steel, which I obtained from Mr. Chas. I. Berg, called for two coats of metallic paint in pure linseed oil. A very peculiar condition has occurred in this building, which, however, is by all means to be expected, for, as I have pointed out many times before, linseed oil is totally unfit for the preservation of steel which comes in contact with cement mortar or any alkaline building material. In the Gillender Building there is not a vestige of paint on the steel, and in order to determine that oxide of iron, or metallic brown, was used in conjunction with linseed oil, I had to make several microscopic investigations of pieces of mortar which had destroyed the oil but had not destroyed the pigment.

STEEL PRESERVED BY CEMENT.—The main feature of the preservation of the steel was the fact that the columns were encased in brick and a rich mortar or grout came in contact with

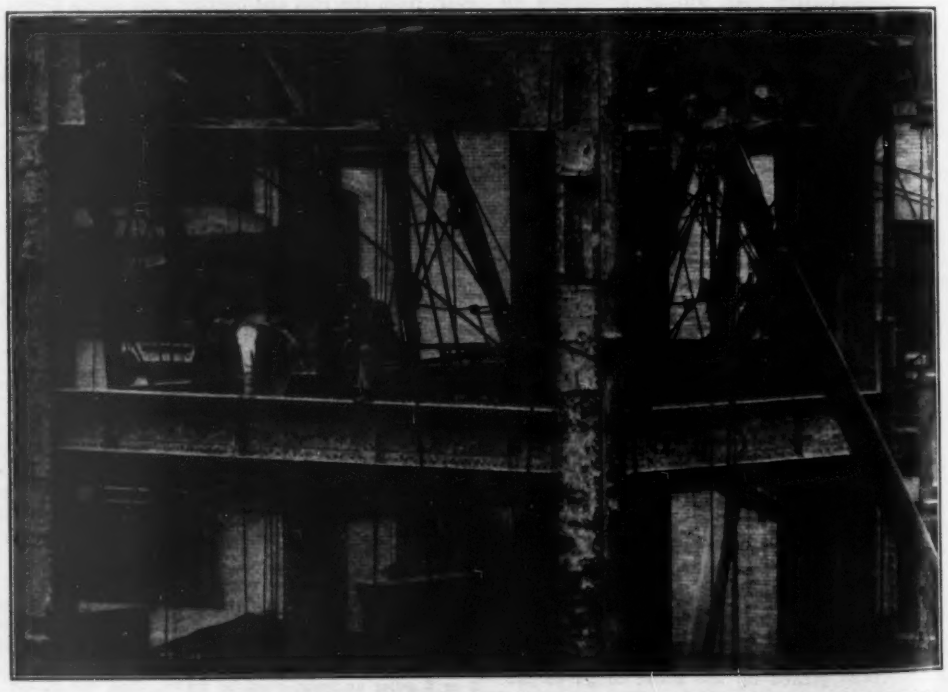

FIG. 3. VIEW AT TENTH FLOOR, SHOWING SOUTHEAST CORNER COLUMN CONSIDERABLY RUSTED.

*Municipal Lecturer on Paint, Concrete and Corrosion, Department of Chemistry, College of the City of New York. Member of firm, Toch Brothers, Paint Manufacturers, 320 Fifth Ave., New York City.

the steel (which also accounts for the complete destruction of the linseed oil). Wherever there was insufficient contact between the grout and the steel, rust formed; but in view of the fact

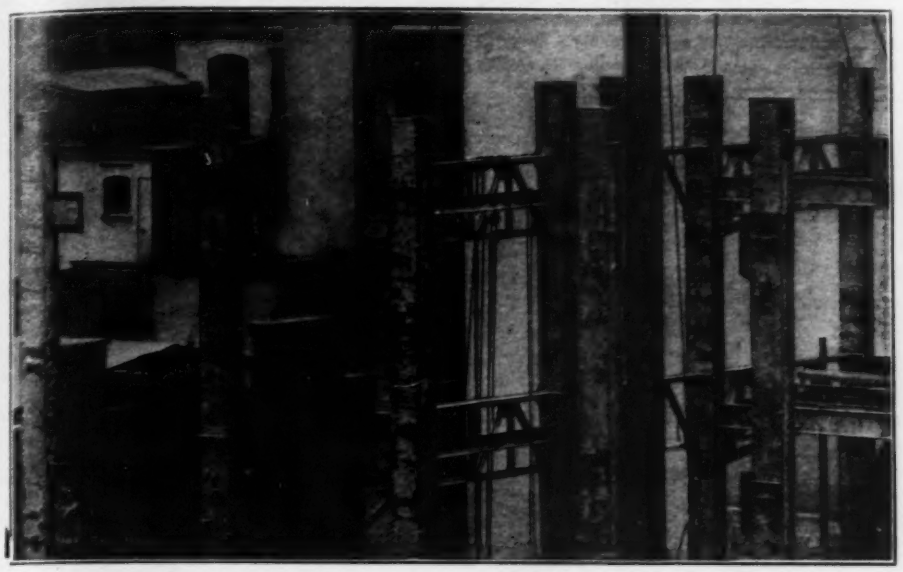

FIG. 4. COLUMNS OF GILLENDER BUILDING AT SIXTH FLOOR.

that the construction of the building was such that moisture was very largely excluded, we have only two or three instances where bad rust pitting took place.

These few instances are mainly accounted for by the quite peculiar fact that the columns which formed the southeast corner, at the intersection of Wall and Nassau Streets (see the photographs herewith), were much more rusty than the steel in any other place. This entire corner indicated that moisture had come through the walls. On this corner, wherever there was no close contact between the grout and the steel, progressive oxidation took place. The next important rusting point of any considerable size was at the last tier of beams and the last columns, at the north end of the Nassau Street side.

In 1896, when this building was being erected, damp resisting paints were in existence but were not favorably known to either architects or builders, so that their use had not become as general as at the present day. There is no doubt that backing the stone would have kept out sufficient moisture to prevent some of the rust which the steel of the Gillender Building shows.

CONDITION OF MORTAR.—It is of further interest to note that the cement mortar which was used for binding the bricks and filling in still shows a remarkable condition. We have all been taught that lime in a free state carbonates on the surface and forms a silicate on the interior, and there is quite some evidence to prove this condition. But the formation of a silicate of lime can evidently only take place in atomic ratio, for which reason I have always held that in the setting of cement calcium hydroxide is set free and can not combine with anything else. This has again been borne out by the various samples of cement mortar which I have taken out of the interior of the Gillender Building, all of which showed a rapid indication with phenolphthalein,* which proves conclusively that free lime was present.

The photographs herewith, most of them telephotographs taken from the roof of the Mills Building, indicate the condition of the steel fairly well.

The one great lesson to be learned from the examination of this steel is the fact that those architects who prescribe a cement mortar one inch thick around a column of steel are very wise in their precautions; but linseed-oil paint should not be used when such a provision is made. There are alkali-proof paints which at the same time electrically insulate and serve a better purpose than the linseed-oil paints.

*For those who have forgotten their chemical training I wish to state that phenolphthalein is an aniline indicator which is a colorless solution, and when a drop or two is placed on concrete, and the concrete contains free lime, it turns a brilliant reddish violet. The concrete of the Gillender Building indicated this continually.

I wish to acknowledge the assistance rendered me by every one connected with the building, particularly Messrs. Marc Eidlitz & Son and their superintendent, Mr. Metzger.

New York State Civil Service Examination for Assistant Civil Engineer.

By "SUBSCRIBER."

The New York State Civil Service Commission held an examination on April 30, 1910, for Assistant Civil Engineer, at a salary of $5 to $6 per diem. Three years' practical experience in civil engineering of a quality satisfactory to the Commission was required; graduation in engineering from a school maintaining a standard satisfactory to the Commission was allowed to count as one year of experience. The scope of

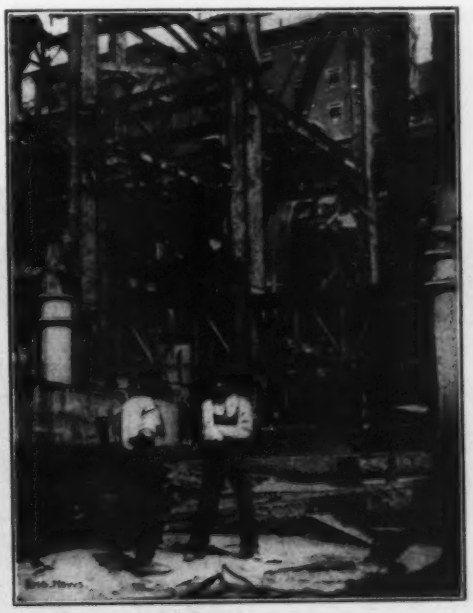

Fig. 5. View of Gillender Building Steelwork at Ground Floor Level; No Paint Visible But Steel in Excellent Condition.

the examination and the relative weights of the various subjects were as follows: Use of field instruments, survey methods and computations, structural mechanics and hydraulics, inspection of materials and work, methods and practice in engineering construction, weight 10; experience and personal qualifications, weight 7; education, weight 3. Candidates were required to be at least 21 years of age and to be citizens and residents of New York State.

The written examination consisted of two papers with a total of 13 questions. The questions on each paper had a total weight of 100, and candidates were allowed to select for answer questions on each sheet having a combined weight of 50. If questions having a greater total weight than 50 were answered, the candidate would be graded on the questions receiving the highest marks and having a total weight of 50. On the first paper, reference books were allowed, and the use of slide rule and logarithms was recommended; on the second paper no helps of any kind were allowed. The time allowed for the written examination was eight consecutive hours. In case insufficient data were given in the statement of the question, it was permissible to make any assumptions desired that would not be inconsistent with the conditions already stated in the question.

First Paper.

1. A highway is to be constructed along a wet, clayey sidehill standing at its natural slope of 2 to 1. The width of subgrade is to be 25 ft. and no part of the highway shall be on fill. The uphill side is to be supported by a reinforced-concrete retaining wall having a top width of 1.5 ft. and increasing uniformly to 2.5 ft. at the top of the footing. The body, or shaft, of the wall is to be located centrally over the footing. Make a detailed sketch section of the highway to meet the given conditions, and determine the amount and disposition of the necessary reinforcing in the wall and footing. Weight, 30.

2. A reservoir taking the drainage from an area about 10 miles' long by 5 miles wide, mostly cultivated open fields, is to have a spillway of sufficient size to carry off all the flood discharge except what may be carried through the blow-off conduit, which is riveted steel, 6 ft. in diameter and 400 ft. long, set flush with headwalls at both ends, and with the center of the upper end 34 ft. below the spillway crest and 40 ft. below the crest at the lower end where it discharges freely into the stream. What length of spillway is required to pass the flow with a head on the crest not to exceed 5 ft.? Weight, 20.

3. The upper chord of a deck railroad bridge is made up of two 15-in. by ⅝-in. plates, spaced 9 ins. apart, two 4 × 4 × ⅝-in. angles, a 20 × ⅝-in. plate on top, and two 6 × 4 × ⅝-in. angles on the bottom with the 6-in. leg horizontal. The ties are set directly on the chord and the rolling loads are 4,000 lbs. per lineal foot, or a single concentrated load of 35,000 lbs. If the direct compression or main stress in the chord (transmitted to it as a main member of the bridge) is 275,000 lbs., and the panel length is 30 ft., determine the maximum stress of section due to all causes. Weight, 20.

4. A dam having a uniform height of 20 ft. above the surface is to be built across a valley 600 ft. wide, upon a foundation of compact gravel. Assuming dam masonry to cost $4.50, embankment 60 cts. and excavation 50 cts. per cu. yd., compute and sketch alternate sections in masonry and earth, make estimates of cost and write a short report pointing out advantages and objectionable features of each for the conditions given, and state under what circumstances each would be more desirable. Weight, 20.

5. In a triangulation survey ABC, station C is inaccessible and invisible from station A. The following angles and distances were measured: C'AB, 75° 6' 45"; CBA, 68° 52' 30"; AC'B, 34° 45' 20"; AC'C, 70° 23' 00"; AC', 2,722.35 ft.; CC', 30.71 ft. An accurate computation of BC is required by the shortest feasible method. Weight, 10.

Second Paper.

6. Compute the live load stresses in all members of a six-panel Pratt truss, 150 ft. long, 30 ft. deep, subject to two rolling loads of 20,000 lbs. each on axles 12 ft. apart. Weight, 10.

7. Explain by sketches and describe how grade stakes are set for the construction of a State highway, both for the heavy grading and for the finish or trimming, and for the surfacing or macadam. Weight, 10.

8. Describe a proper method of building a bridge pier, about 30 ft. by 8 ft., in plan, and 40 ft. high above mean low water in the upper Hudson River, say at a point where it is shallow, has a rock bed overlaid with bowlders, and a fall of about 10 ft. per mile. The depth of water may increase from 3 ft. to 12 ft. during floods. Also sketch suitable cofferdam and explain the manner of putting it in. Estimate plant and force and time required for the job; also the cost. Make a sketch of the site and conditions as you imagine them. Weight, 20.

9. Describe the instrumental work necessary in the above-mentioned work. Show in detail how the preliminary survey would be carried through, what points set, what party required and for how long, and explain how the line and grades for building the pier would be given. Make sketches. Weight, 20.

10. Write in proper form a specimen monthly estimate for a contractor putting in the pier mentioned in question No. 8. Weight, 10.

11. What is the purpose of tests of Portland cement for fineness and for specific gravity? Name the standard tests in the order of their importance and state minimum requirements in each case. Weight, 10.

12. What are the important adjustments of transit and level and how and how often should they be checked up and in what order? Explain what is meant by double centering. Weight, 10.

13. Make an itemized estimate of cost of a mile of water-bound and bituminous macadam surfacing and discuss the ultimate economy of each for various conditions. Weight, 10.

The Municipal Wharf at Montgomery, Ala.; A Novel Solution of the River Loading Problem.

By G. C. SCHERER.*

With the deepening by the General Government of many of the streams in the South, the question of dock facilities has been brought prominently before those interested in shipping by water. Particularly is this true of many of the streams where the banks are high and steep, and where freshet-seasons prevail, which make it impossible to erect wharves at any point below the present stages. Take, for instance, the Alabama River: The water level varies from 0 ft. to 40 ft. during the year, and a fixed dock which would be available during a portion of the year would be 5 to 35 ft. below water-level during the rest of the year.

From the earliest history of transportation on the Alabama River the means used for loading and unloading at points where the river banks are high (conditions which exist especially at Montgomery and Selma) have been of the most primitive character. An inclined slideway composed of timbers was mostly used. It was not an uncommon sight to see a negro start a bale of cotton on such a slideway, and if he were not quick enough to release his cotton hook a confused mass of cotton bale and negro would make its way to the deck, oftentimes resulting in injury to the man and the loss overboard of the bale.

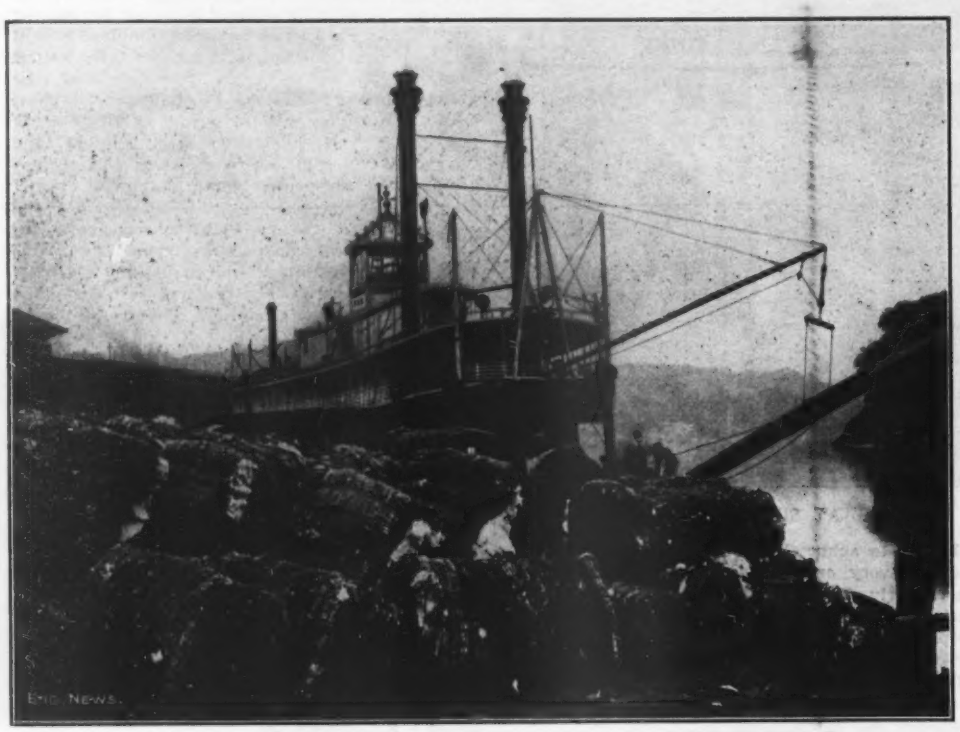

FIG. 1. OLD WHARF CONDITIONS ON THE ALABAMA RIVER. LOADING COTTON AT HIGH WATER.

*U. S. Engineer Office, Montgomery, Ala.

sists of a double railroad track on concrete piers leading from a warehouse on the bank to the lowest water level. On this double track there is placed a movable wharf, which is lowered or hoisted as required to remain always at the water's edge. Barges or boats are thus able to lie alongside the wharf at all stages.

On the same track there are also operated independently of each other, two electrically-controlled cars or small platforms. While one car is being discharged on the wharf the other is being loaded, thus enabling the loading of boat or barge to be continuous.

The commerce of the Alabama River is important, consisting principally of cotton, cotton seed, fertilizers, grain, lumber, shingles, naval stores, staves, and large quantities of miscellaneous freight of all descriptions, reported by the steamboat owners for the calendar year 1908 as about 78,593 tons, valued at $7,000,000. In addition, very large quantities of sawn and hewn timber, saw logs, cord wood, etc., consisting of yellow pine, sycamore, cottonwood, poplar and ash, are barged and rafted down this stream to Mobile, the value of which is estimated at $2,000,000. Considering this volume of yearly commerce on the Alabama River, the saving in cost of handling shipments over the old roustabout method, a relic of slavery, will enable water transportation to compete with that by rail. Should similar means be adopted throughout the South on rivers subject to great freshet variations, the question of dock facilities would seem to have been solved.

FIG. 2. INCLINED TRACK OF THE NEW MUNICIPAL WHARF ON THE ALABAMA RIVER, AT MONTGOMERY, ALA.

The city engineer of Montgomery, Mr. A. R. Gilchrist, seems to have solved the problem of a wharf for use on streams subject to great variations. The arrangement now in active and successful use at Montgomery (Figs. 2 and 3) con-

THE ABOLITION OF TOLL ROADS IN PENNSYLvania will be recommended, according to reports, by the Toll Roads Commission appointed by the last Legislature. It is stated that 107 companies now control 713 miles of roads in Pennsylvania. The average cost of these roads is placed at between $3,000 and $4,000 per mile. The range of dividends paid by the companies, as reported, is from 18 to 1%, and the average 3.44%—or 5.11% if non-paying roads are excluded. The estimated cost of abolishing all these toll roads is placed at $2,000,000. It is proposed that one-half of this cost be met by the state and one-quarter each by the counties and the boroughs through which the roads run. It is also proposed that the machinery for abolishing the roads be set in motion by a petition of ten citizens in the case of each road the petition to be addressed to the Dauphin County Court. The court in such cases would appoint three "viewers" who would report to the court its findings. If the "viewers" and the owning companies agreed, the court would then declare the road free; otherwise, it would appear from press reports, that the "viewers" would fix a price and that either party would have the right of appealing from the valuation, in which case the usual condemnation proceeding under the Pennsylvania law would be violated.

The Relative Value of Irrigating Waters.

By HERMAN STABLER.*

The alkali problem in all its phases is of great importance in those sections of the arid region where water is available for irrigation, for few, if any, of the fertile irrigable areas of the country are so well situated with respect to natural drainage that their producing capacity cannot be impaired by neglect of the principles governing the concentration and rise of alkali.

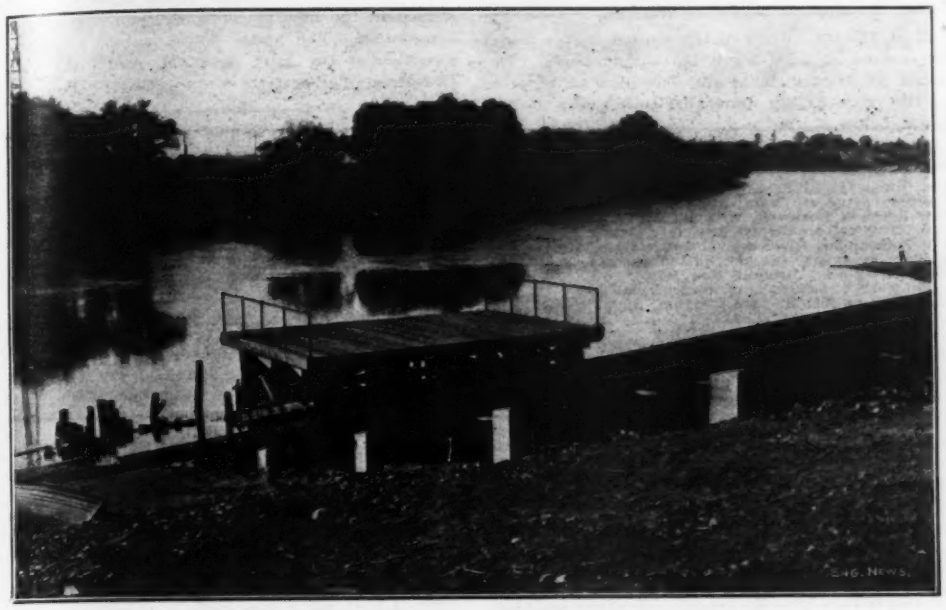

FIG. 3. MOVABLE DOCK IN POSITION ON TRACK.

Concentration of alkali is a necessary accompaniment of rock weathering and soil production. The alkali bases are widely distributed in nature and form nearly 5% of the lithosphere. The weathering of rocks results in a gradual liberation of the alkali bases and water dissolves and transports them to a place of concentration. In the humid regions the rainfall percolates through the soil in abundance, seeps out into streams and finally reaches the ocean. Thus the soil is washed free from large amounts of alkali while the ocean is ever increasing in salinity. In many sections of the arid West, on the contrary, rain falls in small quantity and dissolves alkali from the soil only to deposit it by evaporation without acting to a great extent as a transporting agent. The relative removal of alkali from the land in different parts of the United States is indicated by Table I.

In this table the terms humid, semi-arid and arid refer, respectively, to area, from which the surface runoff is as great as 0.5, less than 0.5 but as great as 0.1, and less than 0.1 sec.-ft. per sq. mi. Neglecting those streams that carry the drainage of large salt deposits, the mean annual removal of alkali bases by streams appears to be about 40, 20, and 10 lbs. per acre, respectively, for the three regions. If the liberation of alkali from the rocks were uniform over the entire country, we should therefore expect a yearly alkali base accumulation of 20 lbs. per acre in the semi-arid and 30 lbs. per acre in the arid regions. At the latter rate highly alkaline soils detrimental to many kinds of vegetation would be produced in a hundred years. The prevalence of great amounts of alkali in districts where irrigation is practiced may thus be readily accounted for. Moreover, the foregoing figures indicate averages for extensive areas, and in some localities the alkali concentration phenomena are undoubtedly very greatly accentuated.

Water applied in irrigation (1) passes over the surface or through the soil and subsoil and is lost as drainage water, (2) evaporates from the surface of the ground, or (3) evaporates from the plant surfaces after serving its useful purpose in plant life. The water evaporated from the soil is not only lost to useful purpose but also adds to the alkali accumulation. It is partially under the control of the irrigator and should always be reduced to a minimum by shading, cultivation, etc. The minimum quantity of water to be supplied for drainage is the amount necessary to remove the alkali in the applied water and the alkali liberated by weathering. The maximum amount that can safely be supplied for drainage depends on the porosity of the soil and subsoil. Use of water in excess of this maximum is followed by waterlogging of the soil and rise of alkali to the level where it is most harmful. Use of water for drainage in amount less than the minimum may be equally harmful but is more likely to result in a very gradual accumulation of alkali. The ultimate success or failure of the irrigator, so far as the alkali problem is concerned, depends upon his ability to apply water in such manner and in such quantity that the drainage water shall always exceed the minimum and never exceed the maximum drainage requirements. Of course, the wider the range between maximum and minimum limits, the less difficult will be successful irrigation. The natural porosity of the soil is of prime importance in determining this range, for it establishes the maximum. Artificial drainage may supplement natural percolation and becomes an absolute necessity when the natural drainage channels do not permit the escape of the minimum amount required for drainage water. Of scarcely less importance in determining the range between maximum and minimum limits is the quality of the irrigating water. Water containing 10 parts per million (0.6-gr. per gal.) of alkali base, applied 1 ft. in depth, will add to the soil nearly seven times the average amount of alkali supplied by weathering; and a foot of water containing 100 parts per million (5.9 gr. per gal.) will add to the soil enough alkali to injure sensitive crops. The additional drainage water required to prevent accumulation of alkali in this manner is very considerable, and from increased minimum drainage requirements result narrowed limits of safe irrigation practice. Normal waters differ greatly, therefore, in their relative value for irrigation in accordance with their content of alkali.

In order that waters may be readily compared with respect to their suitability for irrigation purposes, a simple index of their irrigating value should be available. The calculation of such an index, designated the "alkali coefficient," is developed in the following paragraphs. The alkali coefficient is a purely arbitrary quantity intended solely to facilitate the comparison of waters to be used in irrigation. It is expressed in terms of inches and may be defined as the depth of water which, on evaporation, would yield sufficient alkali to render a 4-ft. depth of soil injurious to the most sensitive crops. Thus, if the alkali coefficient of a water is found to be 17, 17 ins. in depth of that water contains sufficient alkali to render injurious to sensitive crops the soil on which it is applied. Whether injury would actually result from the application of such a water to any particular piece of land, however, depends on methods of irrigating, the crops grown, the character of the soil, and drainage conditions; and it should be distinctly understood that the alkali coefficient in no way takes account of such conditions.

*Assistant Engineer, U. S. Reclamation Service, Washington, D. C.

TABLE I.—YEARLY REMOVAL OF ALKALI (Na + ¾ K) BY SURFACE WATERS IN THE UNITED STATES.

River and station.	Alkali, lbs. per acre.
Arid Drainage Basins.	
Little Colorado, Woodruff, Ariz.	6
Gila, San Carlos, Ariz.	7
Colorado, Austin, Texas.	11
Rio Grande, El Paso, Tex.	12
Rio Grande, Laredo, Tex.	12
Brazos, Waco, Tex.	13
Milk, Havre, Mont.	15
Colorado, Yuma, Ariz.	27
Pecos, Carlsbad, N. Mex.	31
Semi-Arid Drainage Basins.	
Platte, Fremont, Neb.	12
Minnesota, Shakopee, Minn.	14
Missouri, Ruegg, Mo.	17
Mississippi, Menard, Ill.	18
Verde, McDowell, Ariz.	20
Yellowstone, Glendive, Mont.	29
Green, Jensen, Utah.	35
Gunnison, Whitewater, Colo.	54
Red, Shreveport, La.	81
Salt, Roosevelt, Ariz.	86
Arkansas, Little Rock, Ark.	90
Humid Drainage Basins.	
St. Lawrence, Ogdensburg, N. Y.	17
Androscoggin, Brunswick, Me.	26
Mississippi, Minneapolis, Minn.	26
Rock, Rock Falls, Ill.	29
Des Moines, Keosauqua, Iowa.	30
James, Richmond, Va.	30
Tombigbee, Epes, Ala.	31
Cape Fear, Wilmington, N. C.	34
Cumberland, Kuttawa, Ky.	34
Delaware, Lambertville, N. J.	37
Tennessee, Gilbertsville, Ky.	37
Flint, Albany, Ga.	38
Wisconsin, Portage, Wis.	39
Alabama, Selma, Ala.	40
Susquehanna, Danville, Pa.	46
Hudson, Hudson, N. Y.	47
Pedee, Pee Dee, N. C.	47
Illinois, Kampsville, Ill.	48
Allegheny, Kittanning, Pa.	55
Savannah, Augusta, Ga.	56
Wabash, Vincennes, Ind.	57
Muskingum, Zanesville, Ohio.	72
Sacramento, Sacramento, Cal.	95

TABLE II.—HIGHEST CONCENTRATION OF ALKALI HARMLESS TO VARIOUS FORMS OF VEGETATION.

(Pounds of Sodium per Acre in 4 ft. Depth.)

Forms of vegetation.	Total alkali.	Sodium sulphate.	Sodium chloride.	Sodium carbonate.
Salt grass	136,000	14,200	27,700	59,200
Salt bush	56,000	40,700	49,300	8,160
Alfalfa, old	39,400	33,200	....	1,020
Alfalfa, young	4,690	3,600	....	
Sorghum	29,100	20,000	3,810	4,110
Kohlrcuteria	26,300	16,500	4,970	4,300
Hairy vetch	24,800	20,600	1,240	1,080
Radish	22,500	16,800	880	3,780
Sugar beet	21,400	17,000	4,030	1,740
Sunflower	21,400	17,000	2,140	760
Modiola	18,700	2,200	16,100	2,070
Grapes	16,300	13,200	3,790	3,290
Artichoke	15,300	12,500	580	1,200
Oriental sycamore	15,300	6,230	8,000	1,390
Eucalyptus amydalina	14,400	11,200	1,160	1,180
Onions	13,700	....	2,290	....
Potatoes	13,700	....	2,290	....
Carrots	10,200	8,050	930	540
Figs	9,430	7,920	325	486
Almonds	9,130	7,350	940	630
Barley	9,120	3,890	2,000	3,280
Gluten wheat	8,690	6,780	580	1,300
Oranges	7,800	6,020	1,320	1,070
Pears	7,480	5,760	540	760
Wheat	6,170	4,900	450	640
Bur clover	6,070	1,840	....	4,900
Apples	5,700	4,610	488	278
Wash. palm	5,430	4,220	400	520
Celery	4,890	1,320	3,780	....
Rye	4,460	3,170	680	417
Goat's rue	4,220	3,520	63	330
Prunes	4,220	2,900	472	590
Peaches	4,090	3,110	398	295
Lupin	4,000	1,760	1,200	1,180
Apricots	3,600	2,800	378	208
Canaigre	3,350	2,960	31	52
Date palm	2,980	1,810	....	1,210
Camphor tree	2,510	1,710	560	139
Lemons	2,060	1,450	315	208
Mulberry	2,060	1,090	880	69
Ray grass	....	2,240	....	....
White melitot	....	1,590	173	208
Grasses	....	....	398	1,000
Kaffir corn	....	....	....	780
Sweet corn	....	....	....	780

Investigations indicate that the harmful accumulation of alkali occurs in the first four feet of soil and subsoil and that damage to vegetation results chiefly from concentration within a few inches of the surface. Table II. (adapted from the results of Loughridge, as tabulated by Hilgard in "Soils," page 467) shows tentatively the maximum concentration of alkali harmless to various forms of vegetation under the conditions of common irrigation practice.

About forty common cultures are included in Table II. and great diversity is indicated for the relative toxicity of the compounds toward the different cultures. The mean results for several cultures of about the same degree of sensitiveness, however, indicate with marked uniformity the relative toxicity of the alkalies toward common cultures to be about as follows: Sodium as Na_2CO_3, 10;* sodium as NaCl, 5; sodium as Na_2SO_4, 1. Table II. indicates further that about 1,500 lbs. per acre of sodium with a relative toxicity of 1 (as above) in 4 ft. depth of soil is barely sufficient to affect injuriously the more sensitive common crops. The foregoing conclusions, being in accord with the results of other investigations, will be used as a basis for the calculation of the alkali coefficient, which may be made from a water analysis by means of the following formulas, which are applicable to analyses expressed in ionic form in parts per million:

Case 1.—When $Na - .65Cl$ is zero or negative,

$$\text{Alkali coefficient, } k = \frac{2{,}040}{Cl}.$$

Case 2.—When $Na - .65Cl$ is positive but not greater than $.488O_4$,

$$\text{Alkali coefficient, } k = \frac{6{,}640}{Na + 2.6Cl}.$$

Case 3.—When $Na - .65Cl - .488O_4$ is positive,

$$\text{Alkali coefficient, } k = \frac{664}{Na - .325Cl - .438O_4}$$

In the foregoing formulas, the sodium and potassium value frequently reported in analyses may be used for Na; in the absence of a sodium or a sodium and potassium determination, Na may be estimated from the equation $Na = .41HCO_3 - .83CO_3 - .71Cl - .52SO_4 - (1.25Ca + 2.06Mg)$ which for safety gives a value about 10% greater than the theoretical; and in the absence of calcium and magnesium determinations, the foregoing equation may be used if the parenthetical expression be replaced by one-half the total hardness (as $CaCO_3$).

Case 1 is applicable to waters that contain more chlorine radicle than sufficient to combine with the sodium present, and involves the assumption that the other basic radicles required to hold the chlorine radicle in solution are as injurious as if replaced by their equivalent reacting value of sodium. The other cases neglect possible injurious effects of basic radicles other than sodium. These assumptions, as applied to normal waters, are sufficiently accurate for practical purposes though their application to soil might lead to serious errors.

Waters to which Cases 1 and 2 are applicable cannot be improved by chemical treatment but are likely to produce only "white alkali" in the soil. Waters to which Case 3 is applicable are likely to produce "black alkali" in the soil and can be improved to the alkali coefficient calculated from the formula for Case 2 by the use of gypsum or "land plaster."

In general, injurious results from the use of a water for irrigation depend largely on drainage conditions and soil texture. Waters with low alkali coefficients may be used successfully on a loose soil with free drainage. The following approximate classification, which is based on ordinary irrigation practice in the United States, indicates in a very general way the customary limitations in the use of waters having various alkali coefficients:

Alkali coefficient.	Class.	Remarks.
More than 18.....	Good	Have been used successfully for many years without special care to prevent alkali accumulation.
18 to 6.....	Fair	Special care to prevent gradual alkali accumulation has generally been found necessary except on loose soils with free drainage.
5.9 to 1.2.....	Poor	Care in selection of soils has been found to be imperative and artificial drainage has frequently been found necessary.
Less than 1.2.....	Bad	Practically valueless for irrigation.

Most stream waters in the United States would be classed as good for irrigation purposes. The mean alkali coefficients and classification of some of the more highly mineralized stream waters is given below.

Stream.	Alkali coefficient.	Class.
Rio Grande at El Paso, Texas.....	17	Fair
Colorado River at Yuma, Arizona.....	14	"
Salt River at Roosevelt, Arizona.....	12	"
Gila River at San Carlos, Arizona.....	9.2	"
Salt Fork of Red River near Mangum, Okla.	9.1	"
Turkey Creek near Olustee, Oklahoma.....	5.3	Poor
Pecos River near Carlsbad, New Mexico....	4.4	"
North Fork of Red R. near Headrick, Okla.	1.7	"
Elm Fork of Red R. near Mangum, Okla..	0.5	Bad

It is interesting to note that all but the last two of these streams are used successfully for irrigation, from 20 to 60 ins. in depth of water being applied yearly, although the alkali coefficients show that much smaller amounts contain injurious quantities of alkali. The success attending their use is chiefly due to the fact that the excess of alkali is carried off in the drainage of the tracts under irrigation.

*The tabulation indicates a relative toxicity of about 6, but on account of the puddling effect of sodium carbonate on soils and the fact that the investigations did not distinguish between bicarbonate and carbonate of sodium, the value 10 is believed to be more satisfactory.

Notes from the Engineering Schools.

STEVENS INSTITUTE OF TECHNOLOGY.—The trustees have acquired the Stevens "Castle," the historic residence of the Stevens family, and its surrounding grounds. This property, it is announced, will be available as a students' Union (clubhouse) at the beginning of the college year, 1911-12. Meeting rooms for student organizations will be provided, together with a library and reading room, a students' dining hall and smaller dining rooms for members of the faculty and for guests. Dormitory accommodations will also be provided for a limited number of students and it is expected that in the near future a dormitory will be erected on the same ground and operated in conjunction with the "Castle." Beginning with September, 1911, the annual charge for tuition will be $225 for resident as well as for non-resident students, but this change will not apply to those now enrolled or who enter in September, 1910. This is the rate heretofore charged to students residing outside the state of New Jersey.

UNIVERSITY OF TEXAS.—The board of regents of this university has authorized the establishment and equipment of a special laboratory for investigating the properties of Texas fuels and clays. This move was prompted by the number of inquiries which have been sent in from outside sources to the university's bureau of economic geology relative to these materials. The new laboratory will be installed in the former power-house of the university and will be under the care of Dr. William B. Phillips, M. Am. Inst. M. E., Director of the Bureau of Economic Geology, who will be assisted by a special expert in fuel and clay analysis. It is expected that the work of installation will be begun in the fall as the building is now undergoing repairs consequent upon the transfer of the power plant to the new power-house.

The purposes of this new laboratory will be to investigate the fuels and clays of the state from a practical standpoint, to determine the gas-producing power of the different coals, lignites, oils and woods, to analyze the gases and ascertain their heating and illuminating qualities and the by-products that may be recovered from them in the process of distillation. It is proposed to put in a small briquetting plant for the purpose of studying the adaptability of coals and lignites to the manufacture of briquettes and to afford to the miners of lignite an opportunity of having their product tested in a practical manner. The investigation of the qualities of the different high-grade clays in the state will be undertaken by the testing laboratory, with a view to ascertaining their suitability for the better kinds of ordinary and paving brick, pottery, decolorizing of oils and greases, etc. The results obtained will be given to the public from time to time through special press bulletins.

It is probable that much of the fuel testing in the new laboratory may be amplified by practical trials in the producer-gas power plant to be installed in the new power-house, which is nearing completion. The power-house will be under the direction of Dr. A. C. Scott, M. Am. Inst. E. E., Professor of Electrical Engineering.

A WRECK ON THE TRANSCASPIAN RY. near Kizilarwat, Asiatic Russia, caused the death of 19 persons and the injury of 30 others.

FOREST FIRES IN WISCONSIN this season have affected 20 counties with a total loss estimated at about $3,000,000. Five mills were destroyed, but the greatest loss was in standing timber.

Heavy rains July 8-10 extinguished many of the Wisconsin fires, as well as some dangerous fires in Michigan's Upper Peninsula.

THE U. S. GUNBOAT "CASTINE" was accidentally rammed July 11 by the U. S. submarine "Bonita," and escaped sinking only by running to the beach near North Truro, Mass. The accident occurred during a mimic attack on the "Castine" by a submarine fleet. The "Bonita" had been running submerged and rose directly beneath the gunboat. The submarine escaped with the loss of her periscope and slight injuries to some of her armor plates, but the dynamo and boiler compartments of the "Castine" were flooded through a 12 × 18-in. hole torn in her hull, making it necessary to beach her. The "Castine," built in 1893, is a twin-screw, steel vessel of 1,177 tons displacement.

AN AEROPLANE WAS WRECKED July 12 during a flying tournament at Bournemouth, England, and the aviator, Hon. Charles S. Rolls, was killed. This is the twelfth fatal aeroplane accident reported since, and including, that in which Lieut. Thomas E. Selfridge, U. S. A., was killed near Washington, D. C., Sept. 17, 1908. Capt. Rolls was competing for a prize for landing nearest to a given mark. He had risen to a good height, shut off his engine and was gliding down in a broad circle when the tail-piece of his Wright biplane suddenly snapped off. The machine dropped heavily to the ground from a height of 100 ft. and was smashed to pieces. Capt. Rolls won fame June 2, 1910, by crossing and recrossing the English Channel in one continuous flight. He was at the head of the British firm of C. S. Rolls & Co., automobile engineers.

NEW AEROPLANE RECORDS for distance, height and speed have been established during the past week. A world's record for speed was made in the aviation meeting at Rheims, July 10, by Leon Morane, a Frenchman, who flew 5 kilometers (3.10 miles) in a 100-HP. Blériot monoplane in 2 mins. 43 secs., giving a mean speed of 68.42 mi. per hr. A record for distance was made in a Blériot monoplane July 10 at Rheims by a Belgian, Olieslagers, who flew 393 kilometers (244.44 miles) in a single flight in 5 hrs., 3 mins. and 5 secs. Records nearly equalling these, and surpassing any previous records, were made by these same men and others on earlier days of the meeting.

At Atlantic City, N. J., July 9, Walter Brookins, in a Wright biplane, surpassed all previous aeroplane records for height by attaining an altitude of 6,175 ft.

TWO FIRST-CLASS BATTLESHIPS WERE AUTHORized at the recent session of Congress. These may cost, exclusive of armor and armament, not over $6,000,000 each, and are to be similar to the battleship provided for in appropriations in the fiscal year 1908-9. Provision is also made for two fleet colliers, at a cost of not exceeding $1,000,000 each; four submarine torpedo boats, to cost an aggregate of not over $2,000,000; six torpedo boat destroyers, " to have the highest practicable speed," and to cost not over $750,000 apiece. Toward the cost of the four submarine torpedo boats, $800,000 was appropriated in the bill just passed, and toward the cost of the torpedo boat destroyers, $2,225,000.

THE NEW BUREAU OF LIGHTHOUSES under the U. S. Department of Commerce and Labor is to be headed by a commissioner at a salary of $5,000 a year. There is also to be a deputy commissioner at $4,000 per year; a chief constructing engineer at the same salary, and a superintendent of naval construction at a yearly salary of $3,000. All four of these officers are to be

appointed by the President, and Mr. George R. Putnam, M. Am. Soc. C. E., has already been named as head of the bureau. The new bureau is to have control of everything pertaining to the construction, maintenance, and repair of lighthouses, signal stations, beacons, buoys, etc. For not over three years, beginning July 1, 1910, the President may "assign army and navy officers to act in lieu of the appointment of civilian lighthouse inspectors," and in the districts which include the Mississippi River and its tributaries the President may assign army engineers to act as inspectors. No additional salary or compensation is to be given in case of assignment of army officers. Officers of the Engineer Corps, U. S. Army, may be detailed by the President "for consultation or to superintend the construction or repair of any aid to navigation authorized by Congress."

MONTHLY REPORTS ON RAILWAY ACCIDENTS must be made to the Interstate Commerce Commission, in accordance with the Congressional act which took effect on July 6, 1910. The reports must be made under oath, and must include every accident "resulting in injury to persons, equipment, or roadbed, arising from the operation" of the several railroads in the country, and the reports must comply with rules and regulations described by the Commission. Annual reports on railway accidents will not have to be made hereafter in connection with the annual financial reports. The act just noted also gives the Interstate Commerce Commission authority to investigate railway accidents. For this purpose the Commission may subpoena witnesses, administer oaths and require the production of books, papers, etc. In case a given accident is investigated by the State in which it occurs, the Interstate Commerce Commission shall, if convenient, make its investigation jointly with that conducted by the State. The Commission is authorized to make its reports on its investigations public, in its discretion, together with such recommendations as it deems fit. No part of any report on any investigation is to be admitted as evidence or used for any purpose in connection with damage suits.

THE UNITED STATES FLOATING DOCK "DEWEY," which was sunk at its berth at Olongapo, P. I., on May 24 of this year (Eng. News, June 9, 1910, p. 686) was refloated on June 29, apparently undamaged by its long submersion. A naval board is now engaged in the inspection of the dock to ascertain the cause of its sinking, but so far no report has been published.

THE U. S. BUREAU OF MINES, which came into existence on July 1, 1910, is under the jurisdiction of the Department of the Interior and is to be headed by a director "thoroughly equipped for the duties of said office by technical education and experience." The director is to be appointed by the President, with the consent of the Senate, and is to receive $6,000 a year. Pending the appointment of the director, Mr. George Otis Smith, Director of the U. S. Geological Survey, is exercising the duties of that office. The employees of the technologic branch of the Geological Survey have been transferred to the new bureau, with the exception noted further on. In accordance with one of the sections quoted below, the duties devolving upon the new bureau may best be stated by quoting from the act as follows:

Sec. 2. That it shall be the province and duty of said bureau and its director, under the direction of the Secretary of the Interior, to make diligent investigation of the methods of mining, especially in relation to the safety of miners, and the appliances best adapted to prevent accidents, the possible improvement of conditions under which mining operations are carried on, the treatment of ores and other mineral substances, the use of explosives and electricity, the prevention of accidents, and other inquiries and technologic investigations pertinent to said industries, and from time to time make such public reports of the work, investigations, and information obtained as the Secretary of said department may direct, with the recommendations of such bureau.

Sec. 4. That the Secretary of the Interior is hereby authorized to transfer to the Bureau of Mines from the U. S. Geological Survey the supervision of the investigations of structural materials [see statement following quotation from act.—Ed.] and the analyzing and testing of coals, lignites, and other mineral fuel substances and the investigation as to the causes of mine explosions; and the appropriations made for such investigations may be expended under the supervision of the Director of the Bureau of Mines in manner as if the same were so directed in the appropriations Acts; and such investigations shall hereafter be within the province of the Bureau of Mines, and shall cease and determine under the organization of the U. S. Geological Survey; and such experts, employees, property and equipment as are now employed or used by the Geological Survey in connection with the subjects herewith transferred to the Bureau of Mines are directed to be transferred to said bureau.

Sec. 5. That nothing in this Act shall be construed as in any way granting to any officer or employee of the Bureau of Mines any right or authority in connection with the inspection or supervision of mines or metallurgical plants in any state.

The portions of the act which directed the transfer to the Bureau of all matters relating to investigations of structural materials were repealed in the Sundry Civil Expenses Act which subsequently passed Congress. The last-named act carried $502,000 of appropriations for the Bureau of Mines, including $310,000 for investigating "the causes of mine explosions, methods of mining, especially in relation to the safety of miners," etc.; and $100,000 for analyzing and tests of coals, lignites and other mineral fuels.

A brief editorial comment on the proposed creation of this Bureau was printed in our issue of March 31, 1910, p. 376.

A 60,000-TON STEAMSHIP is to be built by the Cunard Steamship Co., the contract calling for delivery within three years. The ship will be somewhat over 1,000 ft. long and will surpass the two large Cunarders, "Lusitania" and "Mauretania" by 200 ft. in length and 30,000 tons in displacement, and will be some 15,000 tons greater in displacement than the mammoth steamers "Olympic" and "Titanic," now being built by the White Star Steamship Co. The name of the builders of the new Cunarder has not been announced.

THE WITHDRAWAL OF PUBLIC LANDS by the President of the United States is authorized by a Congressional act approved on June 25, 1910, as follows:

Be it enacted, etc., That the President may, at any time in his discretion, temporarily withdraw from settlement, location, sale, or entry any of the public lands of the United States including the District of Alaska and reserve the same for water-power sites, irrigation, classification of lands, or other public purposes to be specified in the orders of withdrawals, and such withdrawals or reservations shall remain in force until revoked by him or by an Act of Congress.

Sec. 2. That all lands withdrawn under the provisions of this Act shall at all times be open to exploration, discovery, occupation, and purchase, under the mining laws of the United States, so far as the same apply to minerals other than coal, oil, gas, and phosphates: *Provided*, That the rights of any person who, at the date of any order of withdrawal heretofore or hereafter made, is a bona fide occupant or claimant of oil or gas bearing lands, and who, at such date, is in diligent prosecution of work leading to discovery of oil or gas, shall not be affected or impaired by such order, so long as such occupant or claimant shall continue in diligent prosecution of said work: *And provided further*, That this Act shall not be construed as a recognition, abridgment, or enlargement of any asserted rights or claims initiated upon any oil or gas bearing lands after any withdrawal of such lands made prior to the passage of this Act: *And provided further*, That there shall be excepted from the force and effect of any withdrawal made under the provisions of this Act all lands which are, on the date of such withdrawal, embraced in any lawful homestead or desert-land entry theretofore made, or upon which any valid settlement has been made and is at said date being maintained and perfected pursuant to law; but the terms of this proviso shall not continue to apply to any particular tract of land unless the entryman or settler shall continue to comply with the law under which the entry or settlement was made: *And provided further*, That hereafter no forest reserve shall be created, nor shall any additions be made to one heretofore created within the limits of the states of Oregon, Washington, Idaho, Montana, Colorado, or Wyoming, except by Act of Congress.

Sec. 3. That the Secretary of the Interior shall report all such withdrawals to Congress at the beginning of its next regular session after the date of the withdrawals.

This act was passed at the earnest solicitation of President Taft, who held that presidential orders previously issued withdrawing public lands were of no legal effect because not specifically authorized by Congress. Following closely on the approval of the act President Taft withdrew some 43,500,000 acres of land, most of which, we understand, had been covered in orders issued by the preceding administration. Press despatches summarize these withdrawals as follows: Water-power, 1,454,499 acres; phosphate, 2,594,113; petroleum, 4,447,119; coal (not including Alaska), 35,073,164 acres. The following is the area withdrawn for the various purposes in each of the states affected by the orders:

WATER-POWER SITES.—Arizona, 107,550 acres; California, 47,819; Colorado, 201,549; Idaho, 230,971; Montana, 122,515; Nevada, 14,501; New Mexico, 14,536; Oregon, 176,721; Utah, 379,912; Washington, 55,439; Wyoming, 103,396 acres.

PHOSPHATE LANDS.—Florida, 27,400 acres; Utah, 107,545; Idaho, 1,102,317; Wyoming, 1,381,851 acres.

PETROLEUM LANDS.—Arizona, 230,400 acres; California, 2,482,750; Colorado, 87,474; Louisiana, 314,720; New Mexico, 419,901; Oregon, 74,849; Utah, 581,564; Wyoming, 255,461 acres.

COAL.—North Dakota, 17,828,182 acres; South Dakota, 2,870,287; Washington, 2,207,967; Arizona, 161,280; Utah, 5,814,287; Colorado, 6,191,161 acres. The withdrawals in the two Dakotas, totaling 20,698,469 acres, are new; the 14,374,695 acres withdrawn in the other four states named are understood to be merely confirmations of earlier withdrawals.

In addition, it is reported that coal lands in Alaska have also been withdrawn.

A SCHOLARSHIP AT WASHINGTON UNIVERSITY, St. Louis, Mo., is offered by the St. Louis Railway Club. Candidates must be sons of members of the St. Louis Railway Club and must submit written applications to the club's secretary, B. W. Frauenthal, Union Station, St. Louis, Mo., in time to be in his hands not later than Aug. 12, 1910. Benefits under this scholarship amount to $250 a year, to be paid in four equal sums on Sept. 1, Dec. 1, Feb. 1 and April 1, respectively. This money is expected to be sufficient to provide the beneficiary with books, clothing, board and lodging and incidentals. Particulars may be learned by addressing the secretary.

COMPETITION FOR A MONUMENT to the late Emperor Alexander II. of Russia has been opened to the sculptors and architects of the world. The monument is not to cost over $200,000 and is to be built in a square in St. Petersburg. It is to consist of a statue of the Emperor, mounted on a stone pedestal. A special committee has been appointed by the present Emperor to call for designs and a jury will award five prizes varying from first prize of $2,900, to a fifth of $580, for the most appropriate designs. Any inquiry regarding this matter should be addressed to the "Committee to Erect a Monument in Commemoration of Emperor Alexander II." (Le Comite pour elever un Monument commemoratif a L'Empereur Alexandre II.), c/o Ministère de l'Interieur, St. Petersburg, Russia.

A CONTINUOUS IMPROVED HIGHWAY FROM NEW York to Buffalo is made possible at an early date by an act recently passed by the New York Legislature. This act makes available on Oct. 1, 1910, the sum of $1,000,000 out of the previously authorized state road funds, instead of having the money come and the work done piecemeal. The money is to be used for the improvement of established routes Nos. 2 and 6, which will fill gaps needed to make a continuous improvement of the main highway from New York to Buffalo. Counties participating in the expenditure thus authorized will receive no further state funds until this extra expenditure has been balanced by road money used in other counties.

THE INTERNATIONAL RAILWAY CONGRESS began its eighth session July 4 in Berne, Switzerland. Meetings of this congress, of which the seventh was held in Washington, D. C., in 1905, occur only at intervals of five years.

STONE FOR MACADAMIZED ROADS in Los Angeles County, Cal., has been investigated for the Automobile Club of Southern California by Mr. F. C. Finkle, M. Am. Soc. C. E., of Los Angeles. Two kinds of stone from quarries of the Riverside Portland Cement Co. were studied. One was a porphyry and the other a dolomite. Tests made by the Smith-Emery Co., of Los Angeles, showed an abrasion loss of 19.5% to 22.9% for the porphyry under the standard rattler test, and a similar loss of 50% to 55.2% for the dolomite. Under the specifications a 20% abrasion loss was allowable for the porphyry and 30% for the dolomite, the latter coming under the classification of low-grade material. After discussing these two stones and taking into consideration experience with the use of one of them on road work, Mr. Finkle submitted his conclusions as follows:

(1) The Crestmore Porphyry is in every way an excellent material for bonded road macadam with an asphaltic binder, and is equal to class "A" rock as specified by the Los Angeles Highway Commission.

(2) The Crestmore Dolomite is wholly unfit for macadamizing roads with asphaltic residuum as a binder and is very much inferior to any road rock called for by the Los Angeles County Highway Commission specifications.

(3) The Pomona-Bassett road now being constructed with Crestmore Dolomite will be a failure, both on account of water entering from cracks due to heavy travel crushing the rock, and water rising into the interior from the adobe subsoil.

(4) A road made from asphaltic residuum and large quantities of limestone dust will form an emulsion which will absorb water and be destroyed by hydrolysis. Limestone dust in paving asphaltum and residuum should only be used in the quantity specified in the specifications for an asphaltum wearing surface for street pavements in the city of Los Angeles.

THE WATER-POWER OF SWEDEN is estimated at an equivalent of 10,000,000 HP., available through at least nine months of the year, according to a report from U. S. Consul-General E. D. Winslow, of Stockholm. The state now owns 277 water-falls, of which the largest known is Trollhättan. It has an estimated total capacity of 80,000 HP., but at present is producing only half that amount.

THE WATAUGA RIVER WATER-POWER PROJECT, seven miles above Elizabethton, Tenn., involves a solid concrete dam, 60 ft. high above foundations, which is now under construction for the Watauga Power Co. The spillway section is 240 ft. in length and the head-wall 60 ft. Three 7-ft. 6-in. steel penstocks will conduct the water to the turbine units, each of which will consist of two 33-in. horizontal-shaft wheels, direct-connected to a 1,250 K.V.A. generator. The power-house will be of concrete up to the windows and of brick above, with a steel roof. Three step-up transformers will raise the voltage from 2,200 up to 4,400 volts, for transmission. The principal market for power will be at Bristol, Tenn., 20½ miles away, but power will also be delivered in Elizabethton and probably in Johnson City. Mr. F. R. Weller, Assoc. M. Am. Soc. C. E., of Washington, D. C., is Engineer in charge of design and construction.

CANALS AND POWER PLANTS to be built at private expense are proposed in connection with the Salt River Project of the U. S. Reclamation Service, the water-supply for which is taken from the reservoir formed by

the Roosevelt Dam. The construction work would be carried out by the Salt River Valley Water-Users' Association under an agreement between it and the U. S. Reclamation Service. The agreement has been authorized by the Government but has yet to receive the official approval by the association named. In effect, the contract provides that the association will advance $900,000 for the construction work indicated. The work will include a cross-cut canal between the Grand Canal and the Salt River Valley Canal, and another cross-cut canal and pipe line from the Arizona Canal to the Grand Canal, and an enlargement of the Grand Canal. A 6,000-HP. hydroelectric plant will be built at the junction of the new Arizona cross-cut and the extension of the Grand Canal, and a 3,000-HP. hydroelectric plant will be built at the junction of the South Canal and the Consolidated Canal. All the work will be done in accordance with plans and specifications prepared by the U. S., and will be under the supervision thereof.

PANAMA CANAL EXCAVATION totaled 2,616,609 cu. yds. during June, a daily average of 100,639 cu. yds. for the 26 working days. The rainfall continued exceedingly heavy, reaching a total for the month of 11.67 ins. The amount of concrete laid during the month was 124,214 cu. yds. and 644,155 cu. yds. of fill were placed in dams, a steady increase over the records for the past few months.

A LONG VOYAGE FOR A SUBMARINE was made by the U. S. Submarine "Salmon," in a through trip from Quincy, Mass., to Hamilton, Bermuda. The "Salmon" left Quincy at 2 p. m., July 5, and reached Hamilton 8 a. m., July 10. The distance is about 800 miles, and the average speed made was between six to ten knots. No convoy attended the "Salmon" on her voyage.

A 400,000-VOLT TESTING TRANSFORMER, recently shipped from the Pittsfield factory of the General Electric Co. for the R. Thomas & Sons Co., East Liverpool, Ohio, is described in a recent issue of the "General Electric Review." The transformer is intended solely for the general testing of transmission line insulations. It has a capacity of 250 KW. and will operate at 60 cycles, with a primary voltage of 1,150 or 2,300 and secondary voltage of 400,000. The low-tension winding follows the usual practice and the high-tension winding consists of a large number of disk coils separately wound and insulated. Before shipment the transformer was subjected for a half-hour run to a voltage of 650,000 with the center of the high-tension winding grounded, and to 400,000 volts with one terminal grounded. The general characteristics of the transformer are as follows: Core loss, 8,400 watts; copper loss, 1,270 watts; efficiency full load, 96.3%; exciting current, 7.18%; impedance, 5.4%; C R drop, 0.51%; reactance, 5.4%; floor space, 5 ft. 7½ ins. × 10 ft.; height to top of lead, 16 ft. 9¼ ins.; net weight, 20,000 lbs.

It is stated that this transformer operates at a higher voltage than any other known built for commercial work.

THE PITTSBURG PLAN OF CITY GOVERNMENT is the name given to an outline for a new charter for the City of Pittsburg, which outline has been prepared by a sub-committee and adopted by a general committee made up of representatives of various Pittsburg civic organizations. Mr. T. Allen Burns is secretary of the committee. Under the proposed plan the powers and duties of the Mayor would remain the same as at present. The Council would consist of a single body of nine men selected at large to serve for four years, four elected at one time and five at another. Each councilman would be paid $6,500 per year. The plan includes provisions for the initiative, the referendum and the recall. Nominations would be made on petitions signed by 5% of the number of voters participating in the last election.

AN INTERNATIONAL EXPOSITION IN CANADA is to be held at Winnipeg, Man., in 1914.

Personals.

Mr. A. G. Wishon has resigned his position as General Manager of the Fresno Traction Co., Fresno, Cal., and will be succeeded by Mr. F. W. Webster.

Mr. Frank T. Chambers, M. Am. Soc. C. E., Civil Engineer, U. S. N., has been detached from the U. S. Coal Depot, California City Point, and ordered to the Norfolk Navy Yard.

Mr. R. W. Le Baron, formerly an assistant engineer, Chicago Great Western R. R., has been appointed Resident Engineer in charge of 45 miles of re-construction between Chicago and Sycamore, Ill.

Mr. W. I. StoneBurner, Superintendent of the Quincy, Omaha & Kansas City R. R., at Kansas City, Mo., has been appointed Superintendent of the Missouri, Kansas & Texas Ry. at Denison, Tex., to succeed Mr. G. Storer, resigned.

Mr. R. P. Black, Assoc. M. Am. Soc. C. E., formerly Division Engineer of the Kanawha & Michigan Ry., at Charleston, W. Va., has been appointed Engineer of Maintenance of Way with the same headquarters. His former office has been abolished.

Rear-Admiral Washington L. Capps, U. S. N., has resigned his position as Chief Constructor and Chief of the Bureau of Construction and Repair. His resignation is ascribed to his not being in entire accord with certain details of the reorganization policy of President Taft and Secretary of the Navy Meyer.

Mr. W. Chase Thomson, M. Can. Soc. C. E., resigned his position as Assistant Engineer of the Dominion Bridge Co., Montreal, at the end of June and has assumed charge of the Canadian office of the Cleveland Bridge & Engineering Co., Ltd., of Darlington, England. His office is in the Canadian Express Bldg., Montreal, Que.

Mr. A. L. A. Himmelwright, M. Am. Soc. C. E., has relinquished his position as General Manager of the Roebling Construction Co., of New York City, which position he had held since 1899, and will engage in general practice as a consulting and supervising engineer with office at Masonic Hall Annex, 23d St. and Sixth Ave., New York City.

Mr. E. T. Archer, Mr. W. B. Rollins and Mr. H. C. Westover have dissolved the firm of Archer, Rollins & Co., consulting engineers, of Kansas City, Mo., and have formed two new and entirely independent companies. One of these is that of E. T. Archer & Co., with offices at 426 Beals Bldg., Kansas City. The second is that of Rollins & Westover, with offices at 534 Beals Bldg., Kansas City.

Engineering Societies.

COMING MEETINGS.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 26-28. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
July 26-29. Joint meeting with the British Institution of Mechanical Engineers at Birmingham and London, England. Secy., Calvin W. Rice, 29 West 39th St., New York City.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 16-19. Annual convention at Niagara Falls, Canada. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
Aug. 23-26. Annual convention at St. Paul, Minn. Secy., John MacVicar, Des Moines, Iowa.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 5-9. Annual meeting at Milwaukee, Wis. Secy., W. C. Woodward, Washington, D. C.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 6-8. Annual meeting at Thousand Islands, N. Y. Asst. Secy., Walter Neumuller, 55 Duane St., New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 6-9. Annual convention at Rochester, N. Y. Secy., Frank P. Foster, Corning, N. Y.

MICHIGAN GAS ASSOCIATION.
Sept. 8-12. Annual meeting on board steamer sailing from Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 13-16. Annual convention at St. Louis, Mo. Secy., A. P. Dane, Reading, Mass.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 21-23. Annual convention at Colorado Springs. Secy., J. C. Lawler, P. O. Box 938, Colorado Springs.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 21-23. Annual convention at Rochester, N. Y. Secy., Willard Kent, Narragansett Pier, R. I.

DETROIT ENGINEERING SOCIETY.—The annual outing July 23 will center about a river trip on the steamer "Sappho."

DEEP WATERWAYS ASSOCIATION.—The third annual convention will be held at Providence, R. I., Aug. 31-Sept. 3. President Taft, it is announced, will be one of those to address the delegates. The president of the association is Congressman J. Hampton Moore, of Philadelphia, Pa.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.—At the 15th annual convention, in Rochester, N. Y., Sept. 6-9, papers will be presented as follows: "Wireless Telephone and Telegraph," "Lightning Protection," "Mercury Arc and Other Rectifiers," "Relation of the Telephone to the General Organization of Fire Department Service," "Underground Work," "Modern Police Telegraph System."

AMERICAN PEAT SOCIETY.—The fourth annual meeting will be held at Ottawa, Canada, July 25-27. On the afternoon of July 25, an excursion will be made to the Dominion Government peat plant at Alfred, Ont., and on July 26 to the government fuel-testing plant in Ottawa. Papers to be presented are as follows:

July 25—"A History of the Peat Industry of Canada," Alexander Dobson, Beaverton, Ont.; "The Government Peat Plant at Alfred," A. Anrep, Jr., Dominion Department of Mines; President's Address, Dr. Eugene Haanel, Ottawa, Ont.; "Draining of North Carolina Swamp Lands: Amount of Peat Found Therein," Joseph Hyde Pratt, State Geologist, North Carolina; "Peat Power Generation," T. Arthur Mighill, Boston, Mass.; "Work of the Peat Engineering Co.," F. J. Bulask, Toledo, Ohio; "A New Portable Peat Machine," Ernest V. Moore, Peterborough, Ont.; "The John Jacob Astor Vibratory Disintegrator for Peat Gas Producers."

July 26—Papers on "The Journal of the American Peat Society," "Peat Investigations of the U. S. Geological Survey" and "The U. S. Bureau of Mines," by Charles A. Davis, Peat Expert, U. S. Bureau of Mines; "Drying Peat," J. McWilliam, London, Ont.

July 27—"Prospect for the Peat Industry in the Northwest," Max Toltz, St. Paul, Minn.; "The Development of Gas Producers for Peat and Lignite," R. H. Fernald, U. S. Bureau of Mines; "Progress of Peat Briquetting," O. E. Moulton, Dover, N. H.; "Future of the American Peat Industry," Wm. Eichhoff, Erie, Pa.; "Some Problems of the Peat Filler Manufacturer," J. N. Hoff, New York City; "Peat as a Fertilizer and Methods of Peat Drying," Robert Ranson, St. Augustine, Fla.; "The Akerlund Gas Producer," Gibbs Gas Engine Co., Atlanta, Ga.; "Peat Litter," J. Bordollo, New York City.

The secretary is Mr. Julius Bordollo, Kingsbridge, New York City.

NEW ENGLAND CONFERENCE ON STREET CLEANING.—A beginning in bringing about free and expert discussion of the problems and difficulties involved in efficient street cleaning work was made through the New England Conference on Street Cleaning, which was held under the auspices of the Bureau of Social Research of Providence, on June 29, at Brown University, Providence, R. I. The primary motive of the conference was local, but the interest shown by the outside public was so widespread that 38 New England cities were represented through their mayors, commissioners of public works or street superintendents, while sanitarians from a number of the largest eastern cities attended the three sessions, which were held on the same day.

Of the nine papers presented, three were of particular importance to the sanitary engineer. These were presented by Dr. George A. Soper, M. Am. Soc. C. E., President, Metropolitan Sewerage Commission of New York; Mr. F. C. Gorham, Professor of Bacteriology at Brown University, and Mr. J. T. Fetherston, M. Am. Soc. C. E., Superintendent of Streets of the Borough of Richmond, New York City.

Dr. Soper, in discussing the segregation of departmental work in street cleaning, held that it is a matter of the greatest importance to place the refuse collecting and refuse disposal authority in the hands of the same division or department, owing to the necessity of placing the power of compelling citizens to comply with the rules concerning the separation of refuse, close enough to the control of the final disposition work to make it of direct interest, to the division or department concerned, to enforce such rules. Dr. Soper also discussed briefly the street-cleaning appliances used in the United States, with a view to emphasizing the inefficiency of such appliances without proper hand labor.

The paper read by Prof. Gorham, upon "The Bacteriology of Street Dust," placed especial emphasis upon the river and tide-water pollution due to the water used for the washing of streets and then permitted to flow directly into the overflow sewage channels without being subjected to the processes to which the household sewage is subject.

Prof. Gorham also called attention to the amount of dust that results from the wear and tear on street surfaces. While the speaker did not maintain that street dust contains as many bacteria as is generally believed, he showed how the injuries to the tissues resulting from the particles of dust that fly through the air predispose the tissue to bacterial infection. For this reason, the importance of constructing roads and streets with materials which do not wear quickly, and therefore of themselves do not produce large amounts of dust, was strongly urged.

Mr. Fetherston, in discussing the "Training of a Street Superintendent," advocated the division of street cleaning departments into two sections—a work section and an efficiency section. The work of the efficiency section, the speaker maintained, should be the establishment of practical ideals and practical standards of efficiency, the devising of systems of measurement which could be used with accuracy in ascertaining the relations between work done and money expended. The staff of the efficiency division should consist of practical engineers who, through their technical knowledge of street cleaning activities, could establish unit measurements of efficiency which would be used as test measurements in all departmental functions.

The addresses by the other speakers related to the general methods of street cleaning, administrative details and such educational work as can be done by the public and by the city officials. At the close of the conference it was voted that a similar conference be held next year. Mr. Carol Aronovici, Director of the Bureau of Social Research, under whose auspices the meeting was held, was appointed chairman of the committee in charge of next year's plans.